WORLD ANIMAL REVIEW

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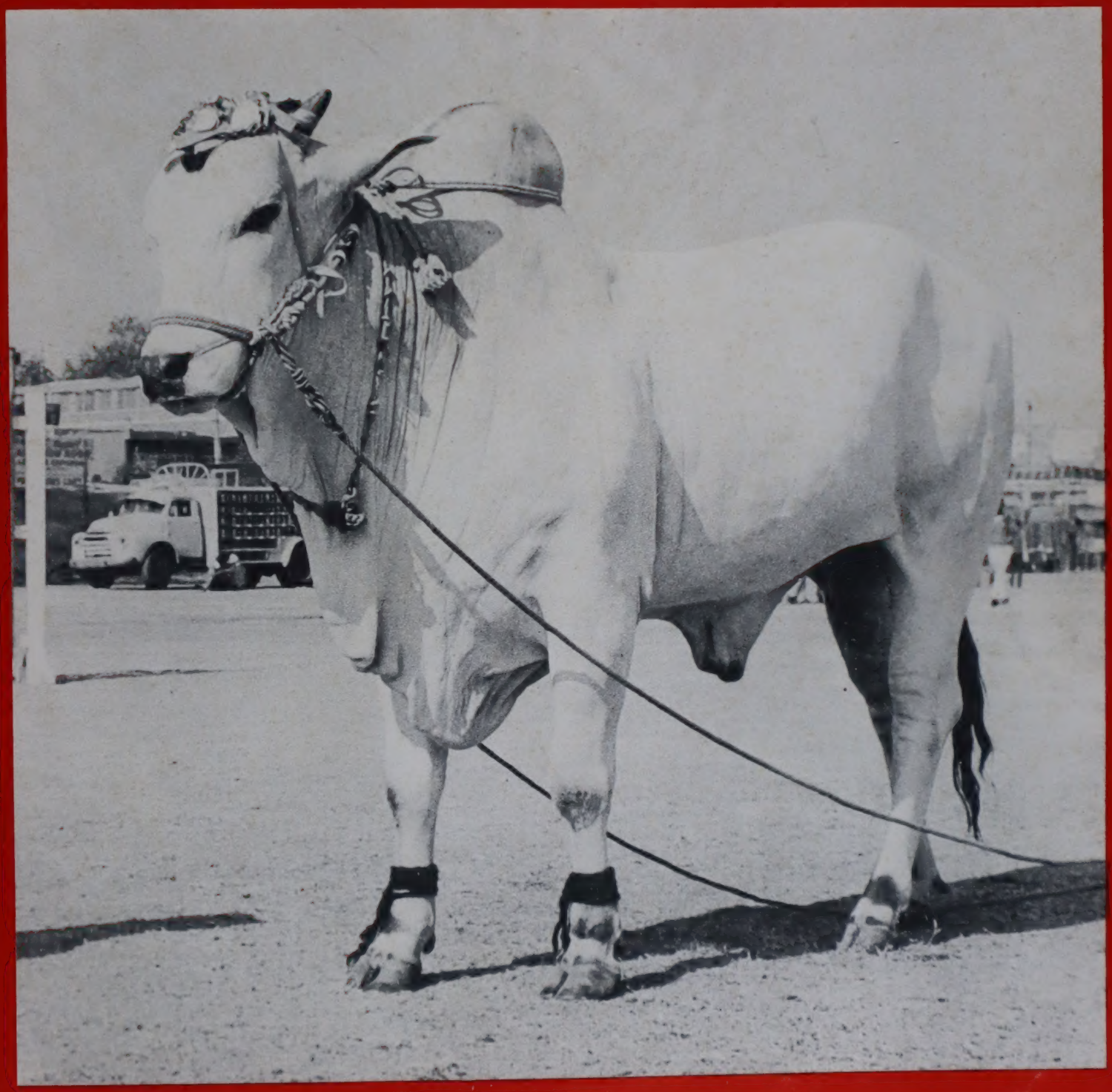

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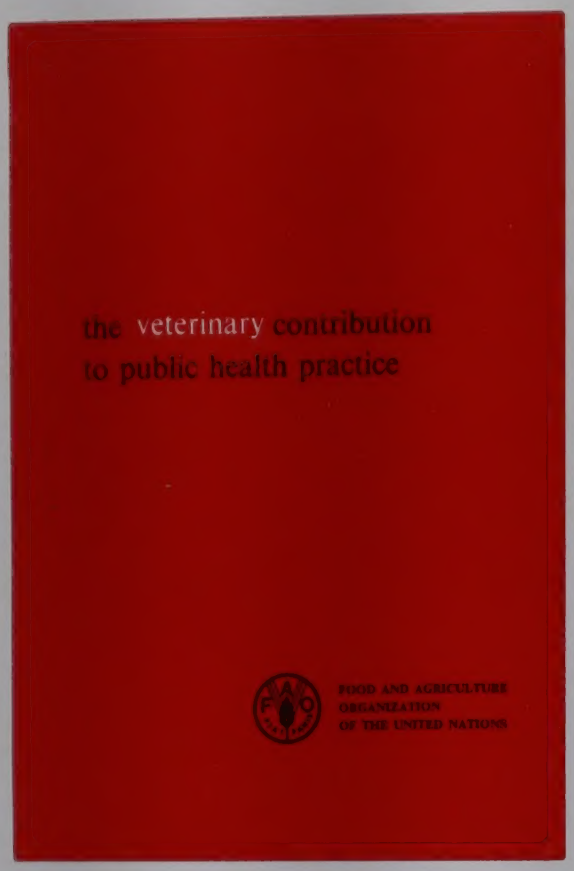

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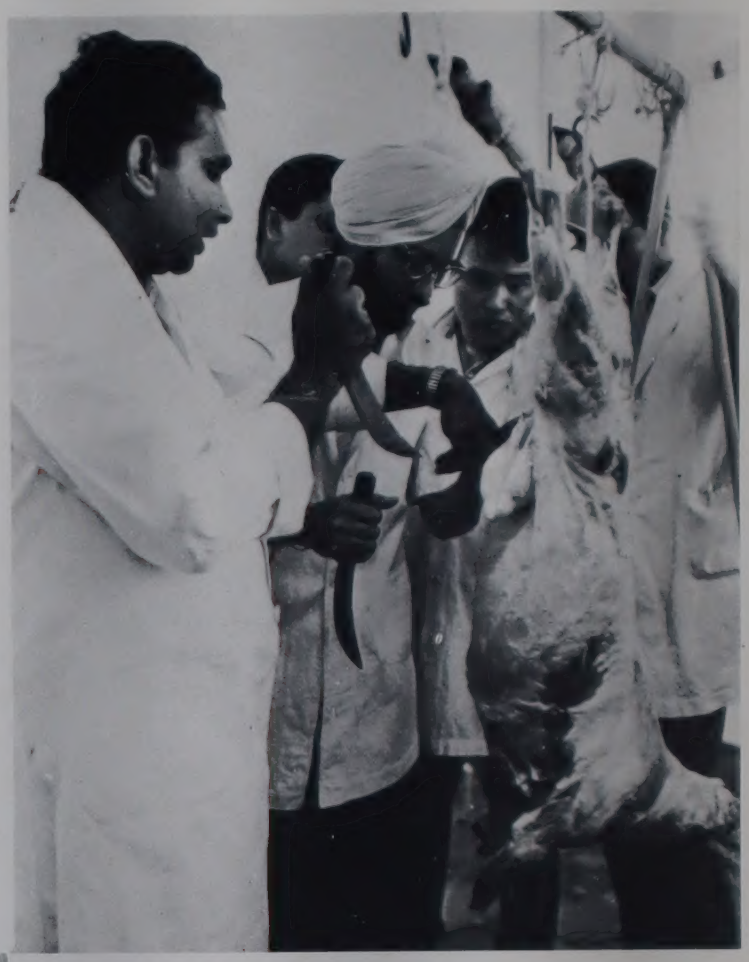

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WORLD ANIMAL REVIEW

a quarterly journal on animal production, animal health and animal products no. 23 - 1977

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COVER: Ongola bull. First-prize winner at the All India Livestock Show, 1974.

Dairy cattle crossbreeding in India

2. The results of the All India Coordinate Research Project on cattle

B.G. Katpatal

The first part of this article was published in *World Animal Review*, No. 22. It stated the objectives of the All India Coordinated Research Project on cattle; the results of the breeding work to the end of March 1976 are reviewed in this article.

The numbers of crossbreds of different genetic combinations at the various centres are summarized in Table 1. As of 31 March 1976 there were a total of 994, 611 and 667 halfbred Friesian, Brown Swiss and Jersey females respectively. The size of the second generation groups was also increasing, and most of the animals were nearly mature but not yet in milk. It is intended to produce at least 100 freedable females in each of the second generation genetic groups.

● DEVELOPMENT of live weight of females crossbred from the Friesian, Brown Swiss, Jersey, Hariana, Gir and Ongole breeds is shown in Table 2.

It may be seen that the Friesian crosses are heavier than the Jersey crosses at all ages. At 18 months of age the difference between the Jersey and the Friesian crosses was 4 kg. Although birth weights of the Friesian and Brown Swiss crosses were equal, 12 months later the Brown Swiss had gained 16 kg less than the Friesians. At 18 months of age the Brown Swiss crosses were intermediate between the Friesian and the Jersey groups.

From limited data it has been observed that body weight of females is lower in groups with 75 percent blood of one exotic breed as compared to either halfbred group or groups with 75 percent blood of two exotic breeds. Further study is in progress.

● CONCEPTION RATES of Hariana cattle compared with those of crossbred females of various grades at Haringhatta are shown in Table 3.

It is evident that conception rates in the crossbreds were significantly higher than in the Hariana. The average conception rate for all the Indian breeds involved in the project is around 29.3 percent, but the figure is slightly higher when computed as first-service conception rate. In the crossbreds the conception rate was 51 percent among halfbred Jerseys on the basis of overall inseminations and 56 percent on first inseminations, compared with 51 and 47 percent for the Brown Swiss and the Friesian halfbreds. The overall first-service conception rate among the crossbred was 51 percent. When frozen semen was used, the conception rate among Friesian sires was much higher than among the Brown Swiss and the Jersey sires used in the project. The breeding efficiency of halfbred females and the fertility of halfbred males when used for producing second generation crosses at the Haringhatta centre are shown in Table 4.

The Friesian and Jersey halfbred males were slightly superior to the Brown Swiss crossbreds in fertility levels; the overall conception rate was 33 percent while conception to first service averaged 39 percent. A similar trend in fertility also occurred among halfbred females when crossbred males of the different breeds were used; this is shown in Table 5.

Valid conclusions cannot be drawn owing to the limited numbers involved, and also because there may have been differences in the techniques of semen collection and processing from crossbred bulls in India compared with those adopted for imported semen.

● AVERAGE AGE at first calving among Friesian halfbreds ranged from 952 to 998 days; among Jersey halfbreds from 865 to 1 007 days and in the Brown Swiss halfbreds from 1 024 to 1 036 days. The mean age at first calving is lowest in the Jersey crosses and highest in the Brown Swiss crosses except at Haringhatta, where the Jersey averages are considerably higher than at the other centres. The results are presented in Table 6 according to breeds and centres.

● AVERAGE CALVING INTERVAL among the halfbreds ranged from 409 to 461 days in the Friesian crosses, 381 to 456 days in the Jersey crosses and 395 to 471 days in the Brown Swiss crosses. The Jersey crosses evidently

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The author is greatly indebted to the scientists in charge of the various units of the project for providing the information on which this article is based. Thanks are also due to the Indian Council of Agricultural Research for permission to publish this article.

TABLE 1. – **Numbers of purebreds and crossbreds as of 31 March 1976 at different centres in various genetic groups**

Genetic groups	Haringhatta		I.V.R.I.		Hissar	
	Males	Females	Males	Females	Males	Females
Foundation (local) cattle	—	245	—	200	—	217
½ F	20	301	16	131	10	105
½ B	75	287	2	127	10	94
½ J	28	268	3	105	10	69
½ F - ¼ B	14	13	11	25	7	24
½ F - ¼ J	16	27	11	28	7	10
½ B - ¼ F	19	17	6	20	7	38
½ J - ¼ F	13	20	10	15	10	28
½ B - ¼ J	16	19	1	12	2	2
½ J - ¼ B	12	6	2	10	3	5
¾ F	14	27	1	4	5	6
¾ B	2	10	—	3	—	—
¾ J	4	55	2	2	—	—
½ F (F_2)	—	67	—	—	—	—
½ B (F_2)	—	17	—	—	—	—
½ J (F_2)	1	39	—	—	—	2
	Jabalpur		Rahuri		Lam	
	Males	Females	Males	Females	Males	Females
Foundation (local) cattle	5	264	7	239	24	465
½ F	9	167	10	125	33	165
½ B	—	—	—	—	11	103
½ J	5	81	12	109	28	34
½ F - ¼ B	—	—	—	—	3	2
½ F - ¼ J	2	6	22	21	—	—
½ B - ¼ F	9	7	10	6	2	2
½ J - ¼ F	7	4	13	13	—	—

F = Friesian; B = Brown Swiss; J = Jersey.

TABLE 2. – **Average body weight (kg) of crossbred females at birth, 6, 12 and 18 months of age**

Breed group	Number of animals	Birth weight	Number of animals	Weight at 6 months	Number of animals	Weight at 12 months	Number of animals	Weight at 18 months
H × F	772	25	508	106	412	181	308	234
H × BS	669	25	342	95	294	165	234	242
H × J	610	20	404	93	323	162	279	222
G × F	255	25	176	97	121	186	128	273
G × J	143	20	129	83	125	156	95	237
O × F	170	27	90	97	50	189	—	—
O × BS	113	27	52	89	35	185	—	—
O × J	34	21	4	79	3	175	—	—

H = Hariana; F = Friesian; BS = Brown Swiss; J = Jersey; G = Gir; O = Ongole.

had a shorter service period than the other crosses.

Since semen quality varied with breed of sire and this would have had a differential effect on conception rates, it is likely that age at first calving and length of calving intervals were probably biased. Further detailed analysis is therefore required to bring out such differences. However, it may be noted that age at first oestrus was lowest in the Jersey crosses and highest in the Brown Swiss crosses, as shown in Table 6.

● AVERAGE LACTATION YIELDS for the different genetic groups are shown in Table 6. The agroclimatic and management variations between locations are reflected in the production levels of the three halfbred groups. The average first lactation yield in the halfbreds ranged from 1 977 to 2 939 kg in the Friesian, 1 575 to 2 487 kg in the Jersey and 1 243 to 2 276 kg in the Brown Swiss. Corresponding figures for the length of the first lactation were 343 to 374 days, 330 to 347 days and 274 to 333 days respectively. The mean lactation yields presented in Table 7 show that the Friesian crosses were higher producers than the Brown Swiss and Jersey crosses. It will also be seen from Table 7 that when the Gir and Hariana breeds were used as the foundation zebu stock, the milk yield in the crosses increased by over 300 percent, whereas the Sindhi and the Sahiwal crosses recorded increases of only 70 to 100 percent at the military dairy farms.

● CONTENT OF FAT, solids-not-fat (S.N.F.) and total solids in the milk of the three groups of halfbreds and in the foundation breeds were recorded at the different centres.

The fat percentage varied from 4.3 to 4.8 in the Friesian crossbreds, 4.5 to 4.9 in the Brown Swiss crossbreds and 4.2 to 5.5 in the Jersey crossbreds at the different centres. Within each centre the fat percentage was lowest in the Friesian and highest in Jersey halfbreds, the S.N.F. and total solids contents also followed the same trend. The Jersey crosses compared favourably with the foundation zebu breeds in milk composition.

Analyses of the other constituents of milk in short-term studies have shown that the percentage of protein in milk average 3.1, 3.2 and 3.3 for the Friesian, Brown Swiss and Jersey crosses, while that of lactose averaged 3.9, 4.1 and 3.9 respectively. Expressed as mg per 100 ml, the calcium content was 128.6, 125.8 and 129.8 and phosphorus was 94.9, 91.7 and 94.7 respectively for the same crosses.

• DISEASES. No evidence at present shows that the crossbreds are any more susceptible than the indigenous breeds to several systemic diseases, with the exception of foot-and-mouth disease and theileriasis. The following results from Haringhatta show that the Brown Swiss crosses had a higher mortality than the Friesian and Jersey crosses:

Crosses	*Mortality according to age group in months*			
	0-3	*3-6*	*6-12*	*12-18*
	..... *Percent*			
Friesian	8.5	1.9	0.4	1.1
Brown Swiss	11.5	3.6	0.8	3.1
Jersey	7.4	2.1	3.0	0.0

At Hissar the overall mortality among halfbred Friesian, Brown Swiss and Jersey females was 6.7, 8.1 and 6.9 percent respectively. The limited data on the second generation ¾-breds derived from the use of two exotic breeds showed that mortality up to 6 months of age was higher than in the F_1 crosses, the principal causes of mortality being enteritis and pneumonia.

• AT MOST of the centres number of female crossbred progeny with completed first lactations is less than 6 per sire used. At Haringhatta, however, there were 5 or more daughters for each of 18 sires (7 Holstein, 4 Brown Swiss and 7 Jersey) and these had completed their first lactation by the end of March 1975. The progeny tests of these bulls (predicted difference), the number of daughters and their average first lactation records are presented in Table 8.

Linear regression coefficients of the

TABLE 3. – **Comparative conception rates of Hariana and crossbred females** [1]

Breed group	Number of inseminations	Pregnant	C.R. (%) [2]
Jersey crosses	1 512	672	45
Friesian crosses	1 736	749	43
Brown Swiss crosses	805	369	46
Total crossbreds	4 053	1 790	45
Hariana: up to 1973-74	10 867	2 183	20
during 1974-75 [3]	560	162	29
during 1975-76 [3]	520	152	29

[1] Irrespective of level of exotic in heritance. — [2] C.R. = Conception rate. — [3] Includes cows and heifers.

TABLE 4. – **Conception rates among Hariana and crossbred cattle when frozen semen was used**

Breed of bull	Breed of female	Total number of inseminations	Conceptions		Number of first inseminations	First-service conceptions	
			Number	Percent		Number	Percent
F, B, J	Hariana	520	152	29	165	53	32
F, B, J	½F	401	185	46	184	87	47
F, B, J	½J	238	121	51	121	68	56
F, B, J	½B	157	76	48	82	42	51
Total		796	382	48	387	197	51
F	½F, ½B, ½J	295	166	56	156	96	61
B	½F, ½J, ½B	257	112	43	124	58	47
J	½F, ½B, ½J	244	104	43	107	43	40
Total		796	382	48	387	197	51

F = Friesian; B = Brown Swiss; J = Jersey.

TABLE 5. – **Conception rates among halfbreds**

Breed of sire	Breed of dam	Total number of inseminations	Conceptions		Number of first inseminations	First-service conceptions	
			Number	Percent		Number	Percent
½F	½F, ½B, ½J	149	49	33	59	26	44
½B	½F, ½J, ½B	147	44	30	54	17	31
½J	½F, ½B, ½J	135	48	35	62	25	40
Total		431	141	33	175	68	39
½F, ½B, ½J	½F	162	45	28	62	19	30
½B, ½F, ½J	½B	94	40	42	42	22	52
½F, ½B, ½J	½J	175	56	32	71	27	38
Total		431	141	33	175	68	30

F = Friesian; B = Brown Swiss; J = Jersey.

TABLE 6. – **Productive and reproductive performance of Hariana crossbreds**

Traits	Unit	Izatnagar		Hissar		Haringhatta	
		n [1]	m	n [1]	m	n [1]	m
F_1 (Friesian):							
Age at first oestrus	days	45	628	57	552	67	738
Age at first calving	days	47	975	54	952	32	998
Calving interval	days	—	409	182	424	134	461
First lactation yield	kg	13	1 977	83	2 939	39	2 531
First lactation length	days	13	377	83	343	39	374
Second lactation yield	kg	15	2 251	68	3 226	80	2 200
Second lactation length	days	15	356	68	336	80	368
Third lactation yield	kg	8	2 492	32	3 440	46	1 867
Third lactation length	days	8	(322)	32	(309)	46	(256)
Dry period	days	—	—	180	96	64	145
F_1 (Jersey):							
Age at first oestrus	days	34	595	44	530	46	733
Age at first calving	days	35	924	33	865	31	1 007
Calving interval	days	—	381	62	394	115	456
First lactation yield	kg	10	1 575	54	2 487	14	1 834
First lactation length	days	10	347	54	333	14	330
Second lactation yield	kg	18	1 738	46	2 730	38	1 983
Second lactation length	days	18	308	46	331	38	362
Third lactation yield	kg	4	2 207	24	2 658	22	1 947
Third lactation length	days	4	285	24	292	22	301
Dry period	days	—	—	33	97	115	142
F_1 (Brown Swiss):							
Age at first oestrus	days	34	677	61	582	47	768
Age at first calving	days	35	1 024	53	1 038	15	1 036
Calving interval	days	—	395	111	417	64	471
First lactation yield	kg	6	1 638	33	2 276	26	1 243
First lactation length	days	6	333	33	333	26	274
Second lactation yield	kg	17	1 692	27	2 405	60	1 758
Second lactation length	days	17	336	27	309	60	312
Third lactation yield	kg	8	1 753	11	2 601	53	1 017
Third lactation length	days	8	281	11	280	53	270

n = Number; m = Mean.
[1] Data for 1975/76 available only; therefore n for second lactation often exceeds n for first lactation.

progeny averages on the progeny test results (predicted difference) in the countries of origin of the bulls were estimated for 15 bulls. These provide estimates of the gains to be derived from selected sires on the basis of their progeny tests in the United States or the United Kingdom for use in India. The regression coefficients for the Friesian, Jersey and Brown Swiss breeds were 1.20 ± 4.91, 0.18 ± 0.24 and $-0.03 \pm .13$ respectively, none of them significant. The results, although based on a limited amount of data, do however suggest that genotype environment interaction may be important with regard to milk yields. The differences in progeny test results in the U.S.A. and U.K. are not reflected in progeny performance under tropical conditions, probably owing to the lower production levels and possibly also to differences among the exotic bulls in their combining ability with Indian cattle; this is at variance with the results reported by McDowell *et al.* (1975) from their studies in Mexico.

● BECAUSE OF THE importance of male animals for agricultural operations and traction work on roads in the cities and rural areas, the comparative performance of ½F, ½BS, ½J crossbred males are under study for ploughing operations and cart work. Ob-

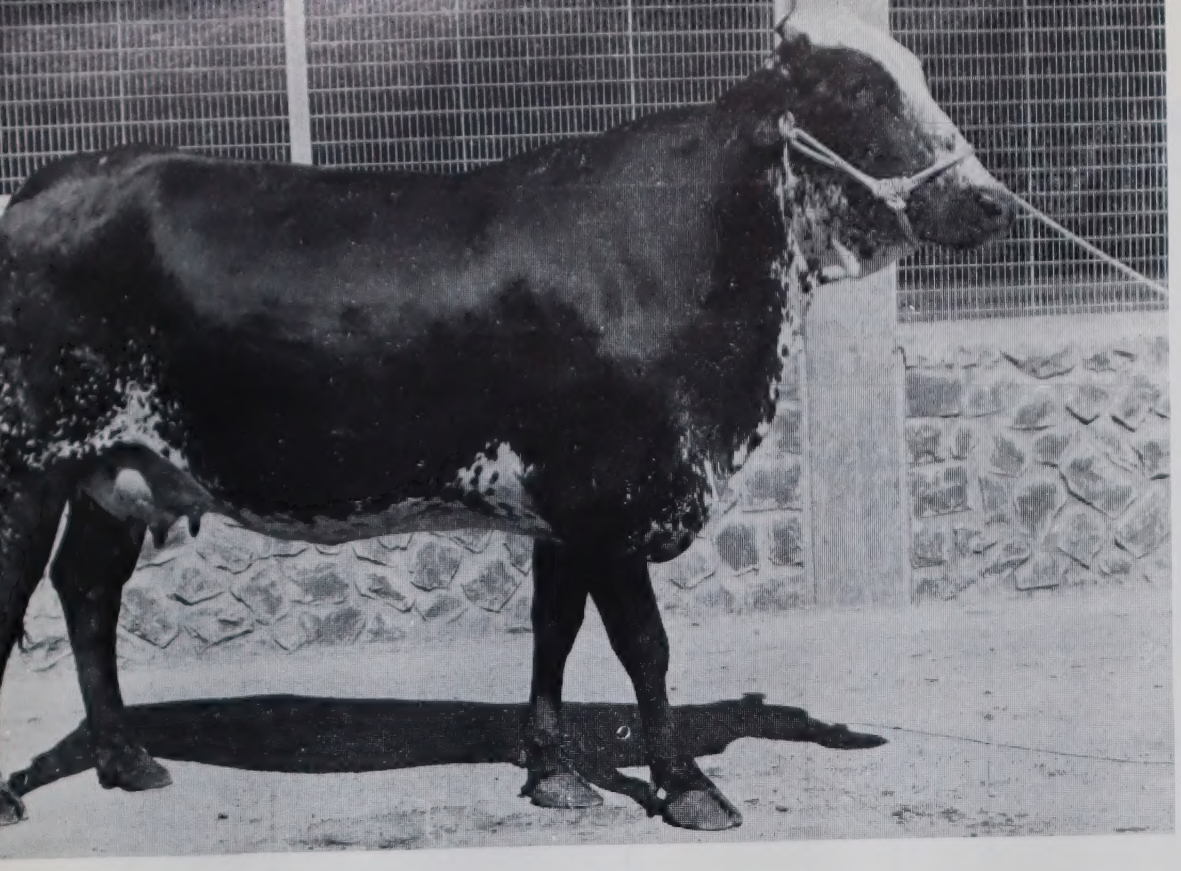

FIGURE 1. *Half-bred Friesian × Coir cow at Rahuri*

FIGURE 2. *Half-bred Brown Swiss × Hariana cow at Hissar*

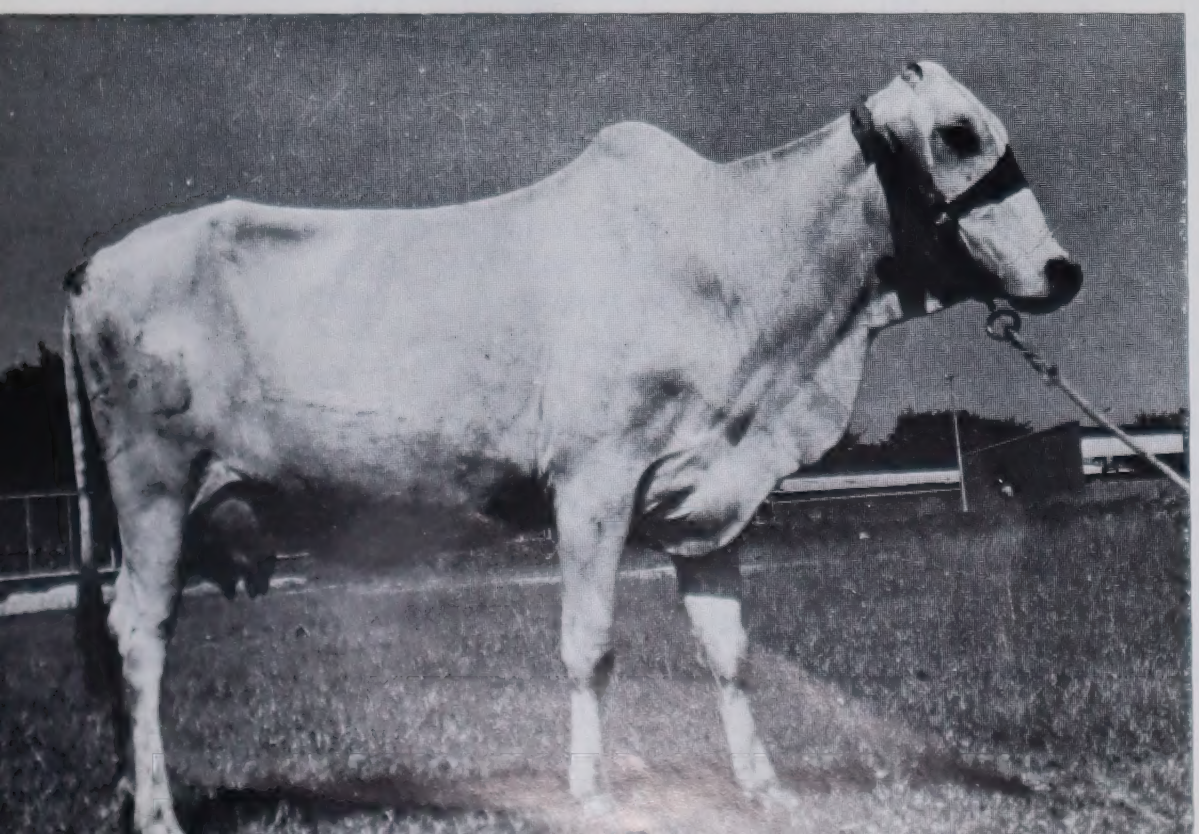

FIGURE 3. *Foundation Hariana cow at Hissar. Her best lactation performance was 2 307 kg milk in 367 days*

FIGURE 4. (ABOVE). *Foundation cow at Rahuri*

FIGURE 5. *Half-bred Jersey × Hariana cow at Haringhatta*

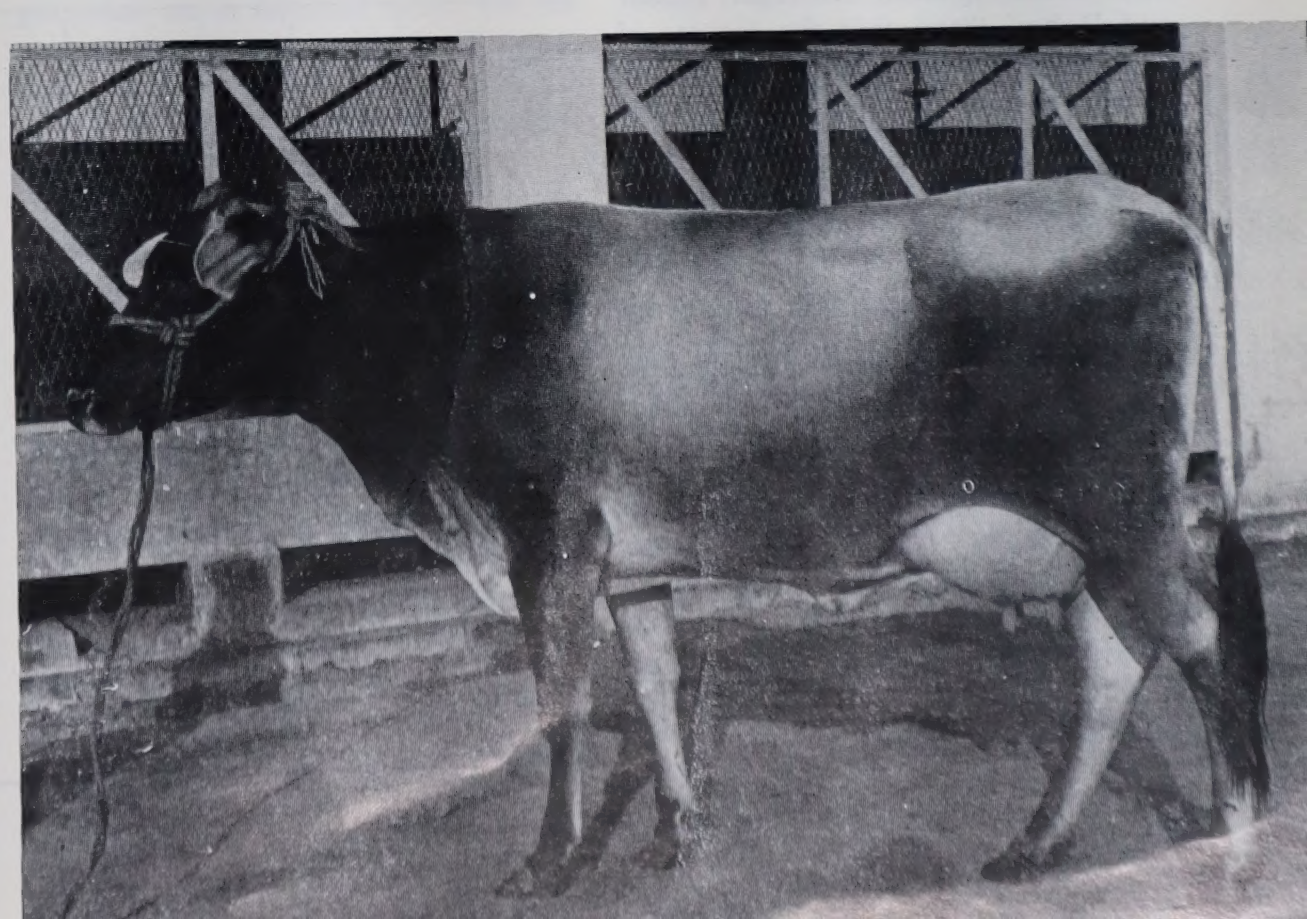

TABLE 7. – **Productive and reproductive performance of foundation zebu breeds at the different centres**

Traits	Unit	Hariana (Hissar)		Hariana (Haringhatta)		Gir (Jabalpur)		Gir (Rahuri)		Ongole (Lam)	
		n	m	n	m	n	m	n	m	n	m
Lactation yield	kg	93	709	93	454	175	758	727	889	448	653
Lactation length	days	93	201	93	234	175	220	727	199	669	279
Dry period	days	44	374	75	270	167	242	338	178	565	361
Service period	days	—	—	90	185	—	—	62	111	243	165
Gestation period	days	—	—	—	—	—	—	128	279	—	—
Calving interval	days	—	—	75	503	168	458	338	405	401	538

n = Number of observations; m = Mean.

servations so far made indicate that the crossbreds can do very well except in the extreme hot, dry summer. It has been reported from Hissar that under such conditions the animals have a tendency to exhibit panting and restlessness. However, the use of crossbred bullocks during the early hours of the day by the farmers in several districts in Uttar Pradesh shows that these animals are suitable for draught and for ploughing.

General conclusions

In view of the short period involved since the start of the All India Coordinated Research Project, it is still too early to draw firm conclusions on the performance of different genetic groups developed from the project.

The results of first generation animals at Haringhatta, Izatnagar, Hissar and Rahuri attest that the crosses of the three exotic breeds (Friesian, Brown Swiss and Jersey) with the Hariana and the Gir are well adapted to the climatic conditions of the dry and humid tropic regions and show great promise for improving milk production. The increases in milk yield obtained from crossbreeding are greater with the Hariana, Gir and nondescript cattle than with the Sindhi and Sahiwal breeds. The Holstein crosses have demonstrated a better growth rate and higher milk production than the other crosses. The ¾ level of exotic inheritance in the later crosses renders them more susceptible to infections at early ages than the half-bred levels.

Current programme and future

Efforts to generate the required number of first and second generation crossbred females so as to produce contemporary genetic groups are being continued. The centralized pooling and processing of data has been organized for appropriate statistical analysis and for conclusions to be drawn. The selection of crossbred bulls for *inter se* matings is in progress, based both on pedigree performance and on progeny tests. Supporting research projects for field and laboratory investigations on the evaluation of heat tolerance, cooling efficiency, efficacy of ameliorative measures during hot and humid months, and upper critical temperatures for lactating Hariana cattle and their crosses have been initiated by the Division of Physiology and Pharmacology of the Indian Veterinary Research Institute and will be extended to other centres. The nutritional trials on the efficiency of nutrient utilization for milk production and on energy and protein requirements of growing animals are in progress in several centres. Reproductive behaviour and related disorders of crossbreds are also being studied.

TABLE 8. – **Average first lactation yield of daughters of exotic bulls in India and their progeny test results in the countries of origin**

Breed of bull	Bull No.	Progeny test results in U.S.A./U.K. (kg)	Number of daughters with completed first lactations at Haringhatta	Average first lactation yield (kg)
Jersey	J-48	+513	17	1 672
	J-16	+225	12	1 731
	J-68	+225	18	1 740
	J-148	+132	4	1 339
	J-26	+ 97	15	1 418
	J-23	+ 94	11	1 737
Holstein	F-566	+ 34	8	2 066
	F-572	+ 26	17	1 614
	F-150	+ 17	13	1 611
	F-623	+ 11	16	1 887
	F-610	+ 9	26	1 895
Brown Swiss	B-41	+452	11	1 616
	B-17	+326	18	1 841
	B-14	+ 40	7	1 741
	B-16	+ 8	15	1 702

FIGURE 6. *Crossbred bullocks at the IVRI, Izatnagar.*

● In view of indications of the possible role of non-additive gene action in milk production in the F_1 generation reported by some Indian workers (and also by Buvanendran and Mahadevan [1975] in their experiments in Sri Lanka), a thorough and extensive probe into this question will be undertaken. The introduction of two exotic breeds in rotational crossing programmes would probably be a suitable alternative to the use of single exotic breeds and the *inter se* mating of the progeny in cattle development programmes. The All India Coordinated Research Project involves three exotic breeds and could therefore provide useful evidence on the possible use of this system in the future.

An important aspect of cattle development, whatever system is adopted, is an efficient sire testing programme. The regular use of tested and proven sires would be the only way to lay a firm foundation for any scheme of cattle development. Although a start has been made in India with progeny testing within a few selected herds on government farms, greater attention should be devoted to organized programmes on a national scale for the progeny testing of purebred and crossbred bulls to meet the large requirements of superior bulls (Mahadevan, 1976).

A study of the social and economic consequences of dairy development through crossbreeding in the Bangalore milk shed area, conducted by the Institute for the Development Research (Denmark), reported results that were not very optimistic for dairying as an instrument for social and economic change in village life. Nevertheless, experience in other parts of India has shown that crossbreds are a valuable asset in improving the economic conditions of farmers. Based on this, appropriate strategies have been worked out for the application of the technology of crossbreeding for the benefit of small and marginal farmers who own the majority of the rural cattle population. This will need to be implemented on a priority basis.

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Toward a more efficient beef chain in OECD countries

D. Béraud

For some years the Committee for Agriculture of the Organization for Economic Cooperation and Development (OECD) has included in its programme of work the study of two chains [1] which are important for all its member countries: the milk chain and the beef chain.

The most recent activity of the Committee was the holding of a symposium on the theme "Towards a more efficient beef chain" from 10 to 13 January 1977 at the Organization's headquarters. One hundred and twenty experts took part.

In a large number of OECD countries concern has frequently been expressed by producers and consumers who consider that excessive profits and certain inefficiencies are the cause of high retail prices and low producer prices. The object of the OECD activity was to consider measures to improve the efficiency of beef and veal marketing.

The symposium made it possible to compile a considerable volume of documentation on the various problems relating to the beef chain, covering most of the OECD member countries. It also provided the opportunity, probably for the first time at international level, for discussions to take place between professional experts and governmental representatives on the basis of experience and studies in various countries. The symposium helped to identify the main problems which arise in the beef chain, and these are summarized below. Frequently these problems were found to go beyond the beef chain itself and were more generally concerned with the new structures and relationships which are developing in the agri-food systems in member countries. The symposium confirmed the need for an overall approach to the agri-food sector, taking into consideration all the economic agents concerned; it also served to emphasize the need for a study of the implications of these developments for agricultural or "food" policies, and for economic policies. The results of this symposium could provide some useful lessons for countries outside OECD, and these are summarized at the end of this article.

Beef production, consumption and trade

The purpose of this article is not simply a presentation of the results of the symposium (which did not adopt any formal conclusions); rather, it is based on the documentation assembled and the experience acquired in the development of this activity. Although the object of the symposium was to study the beef chain, it should be borne in mind that other activities of OECD are oriented toward the study of the problems of meat production, consumption and trade. There is in fact a specialized working party on meat which meets twice a year to consider short- and medium-term prospects. Moreover, OECD has recently made a study of trends in world sup-

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[1] A chain is defined as comprising all the different stages between the producer and the consumer; essentially, it includes the collection of the product and its processing and marketing at the wholesale and retail stages.

ply of and demand for major agricultural commodities,[2] which includes a section on beef and veal.

Table 1 shows the beef production, consumption and trade of the OECD countries, which have been divided into groups according to geographical situation and economic role. The table highlights the following features:

- Except for Japan (where protein consumption consists largely of fish), member countries generally have a high level of beef consumption, a characteristic of industrialized countries. However, more detailed study shows that the level of beef consumption per head and its share in total meat consumption vary considerably from one country to another.
- The highest levels are recorded either in the exporting countries (Australia and New Zealand) or in the major producing countries (North America, in particular). Consumption per head in Europe as a whole is substantially lower, the relatively low levels in northern Europe being explained by food habits in which other protein-rich products of local origin (fish, and milk and milk products) play a large part.
- During the ten-year period 1960-70 and until about 1973, beef and veal demand increased steadily, particularly in countries where levels had been low, in relation to the rise in the standard of living. However, even during this period the increase was substantially lower than the consumption of all meat, and particularly poultry meat, the relative prices of which were lower. Consequently, since 1974 the trend in a number of European countries has been toward a smaller increase, a levelling-off or even a decline in consumption of beef per head. The clearest illustration of this last trend is provided by Italy (decrease estimated at about 1 kg per head per year since 1973); but in other European countries also the figures show a levelling-off at around the 1974 level. Economic difficulties and the trend in relative prices of beef are responsible for these recent developments, while in the exporting countries the difficulty of finding export outlets has led to a considerable increase in internal consumption.
- Another characteristic is the high concentration of trade flows with two major net exporting regions, Oceania in the OECD area and Latin America outside that area. Except in high phases of the beef cycle, Europe is a net importer, while the United States mainly imports beef for processing.

Consumers, at one end of the chain, are numerous, dispersed and insufficiently trained and informed. Their requirements with regard to beef and veal, or beef and veal products, are a good quality/price ratio, wholesome products not containing too much fat, and meat which is sufficiently tender and with good organoleptic characteristics. They also tend increasingly to ask for products which are easily identifiable and which can be prepared rapidly.

If consumers are to play their full part, more must be done to improve their education, information and representation, in close cooperation with

FIGURE 1. *Factory production of minced beef calls for rigourous hygiene*

[2] *Study of trends in world supply and demand of major agricultural commodities.* Paris, OECD, September 1976.

the meat industry, by the following means:

- Improvement of labelling which must be more descriptive and more precise, notably in the case of pre-packed cuts, giving indications of the quality grade, origin of the cut, price per kg, weight of cut, length of time it will keep, etc., and also ways of using the meat.
- Genuine education of the consumer in close cooperation with the retail trade by means of school curricula and special programmes for adults.
- Consumer representation, notably in governmental or semi-governmental bodies associating the various agents in the beef chain. In this way consumer requirements may be made known, discussed with representatives of the meat industry and solutions acceptable to all may be found, taking into account the existing constraints. It may also be hoped that consumers will be better able to understand and thus to help to solve certain general problems such as the seasonal nature of production and imbalances in the consumption of certain cuts.

Retail trade

The retail sale of beef and veal is carried out jointly by supermarkets and traditional butcher shops, though the respective shares and trends vary widely from one member country to another. This diversification of the distribution system seems to meet consumer requirements, particularly in Europe. It should therefore continue, without however preventing each of the sectors from developing in order to improve their service to consumers.

Self-service shops constitute the best structure for the supply of "boxed beef" or meat prepacked in a controlled atmosphere, which must be sold within an extremely short time. This form of distribution makes it possible to achieve economies of scale, especially if supplied from efficient central cutting facilities (for example, supermarkets). It is necessary, however, to ensure that these savings are reflected in retail or producer prices. At the same time self-service shops, and in particular supermarkets, should study methods of providing more personalized information.

Traditional butchers provide a certain number of personalized services which are appreciated by their customers, but these are expensive. To be really efficient and to continue to play their part, traditional butchers will have on the one hand to improve their turnover and reduce their costs by multi-specialization and the re-grouping of purchasing, and on the other to improve the quality of their service to the consumer (in particular, information and advice for housewives).

Away-from-home consumption

Collective catering, which is developing rapidly but in different forms in the commercial (restaurants, bars etc.) and in the institutional sectors (school meals, factory canteens etc.), offers interesting outlets for beef, since the latter is suitable for delivery in individual portions and allows the use of lower grade cuts. On the other hand, efforts to provide low-cost food may stimulate the use of meat analogues which can be a threat to meat consumption. In some countries the development of collective catering has led to the creation of special supply channels which could have considerable effects on production.

Slaughter, wholesale distribution and processing

The method of marketing live cattle has been changing rapidly over the last twenty years. Although the central markets which were the principal places of price formation are on the decline, some experts think they are very important as a means of safeguarding market transparency. Direct sales are developing, and it is becoming increasingly essential to find new

TABLE 1 – **Key figures for OECD member countries**

	North America [1]	Japan	Oceania [2]	European Economic Community [3]	Other European OECD countries [4]
			Kilograms		
CONSUMPTION PER HEAD OF BEEF AND VEAL					
1961-65	44.4	2.0	44.9	22.6	12.1
1966-70	50.0	2.1	41.4	24.5	14.6
1971-74	51.7	3.4	45.0	24.8	15.4
CONSUMPTION PER HEAD OF ALL MEAT					
1961-65	97.0	10.8	108.6	67.5	38.3
1966-70	106.9	16.5	110.1	72.8	46.7
1971-74	111.4	23.7	115.7	79.6	54.7
			Percent		
RATES OF SELF-SUFFICIENCY FOR BEEF AND VEAL PRODUCTION					
1961-65	96	97	198	92	91
1966-70	95	95	232	92	87
1971-74	94	83	225	90	95
			Million inhabitants		
POPULATION					
1961-65	205.3	95.9	13.6	238.9	76.9
1966-70	218.0	101.5	14.9	248.2	80.0
1971-74	229.9	107.4	16.1	255.7	82.5

Source: Meat balances in OECD member countries, 1961-1974.

[1] United States and Canada. — [2] Australia and New Zealand. — [3] Belgium, Luxemburg, Denmark, France, Germany, F.R., Ireland, Italy, Netherlands and United Kingdom. — [4] Austria, Finland, Greece, Iceland, Norway, Portugal, Spain, Sweden, Switzerland and Turkey.

machinery, such as tele-auctions and committee pricing, to maintain a competitive environment with new methods of sale.

Technical advances (for example, the development of the cold chain and refrigerated transport) have been the principal factors contributing to the change-over from transport of live animals to transport of meat, with the result that an increasing number of slaughterhouses are located in the production areas. This has led to the underutilization of slaughterhouses in consumption areas and has created a difficult situation for many communal slaughterhouses, although government protection measures have sometimes slowed down this trend.

In most cases slaughterhouses, wherever their location, are underutilized owing to seasonal and longer term fluctuations in supply and demand. This is a problem which producers must help to solve by developing, wherever possible, systems of production which facilitate regular supply. Fluctuations in import demand can also be a cause of underutilization of slaughterhouses; storage and import policies are needed to remedy these problems.

The function immediately following slaughter i.e., cutting, which formerly took place either in slaughterhouses or in the traditional butcher shops, is being increasingly centralized to meet the needs of supermarkets and traditional butchers. This centralization makes it possible to reduce costs by the industrialization of operations but increases the cost of transport. It would seem, however, that the large modern units should develop with a certain concern for flexibility.

Producers and problems raised by changes in the beef chain

At the other end of the chain producers, like consumers, are numerous and dispersed and have little economic power. They have often reacted either by grouping together to obtain better control of supply through the formation of producer groups or cooperatives for the marketing of live animals, or by integrating with other functions such as slaughtering, cutting and wholesaling, in association with the private sector.

The development of producer groups, cooperatives and other forms of association is very uneven in the different member countries. They are most important in Sweden, Denmark, Ireland, France and the Federal Republic of Germany. The development of such groups raises a number of problems but has made it possible to obtain certain beneficial results.

One of the fundamental characteristics of producer groups and cooperatives is the establishment of increasingly close contractual links between the producer and his group or cooperative. When these are well established, they can be of benefit both to the producer by providing him with services enabling him to reduce his production costs and guaranteeing outlets at reasonable prices, and also to the cooperative slaughterhouse by ensuring regular supplies.

Groups and cooperatives encounter problems of management which are inherent in their nature. It is in fact difficult but desirable to guarantee the producer maximum remuneration while at the same time ensuring factory modernization in an integrated group. It is desirable, when a cooperative gets larger, to establish decentralized structures to protect the producer's participation in decision-making and to ensure that he is kept informed.

Government action to improve the efficiency of the beef chain

Producer groups and cooperatives afford the producer greater security with regard to outlets and prices; they help him in the marketing sector, where mechanisms and channels are complex, and enable a real bargaining power to be established. Competition between the cooperative and noncooperative sectors remains keen in almost all countries where the two sectors coexist. Both sectors have their place and a balance between the two seems desirable.

Clearly government aid, which should be moderate, remains essential, at least during the initial stage of the development of cooperatives and other forms of association.

The role of government is to provide aid in the light of the marketing system chosen to improve the efficiency of the chain, and to put an end to abuse. In a very liberal market economy, such as that of almost all OECD countries, action is limited to the following.

- Improving the transparency of the market and marketing channels, with a view to more efficient price formation, by means of: improved classification of animals and meat; better knowledge of margins for each of the main marketing channels; and establishment of new procedures for determining producer prices. These measures are complementary and should be introduced simultaneously to achieve maximum effectiveness.
- Achieving a balance of market power between the different economic agents, either by encouraging the least organized (incentives for the development of producer cooperatives) and the weakest (improvement of structures and management in the small trade sector), or by limiting the power of agents considered to be too strong (for example, by application of anti-monopoly legislation).
- Trying to organize concerted action between the agents in the chain by setting up specialized bodies.

Some governments, however, have gone beyond the stage of spot measures and have attempted to organize the whole chain. Consideration was given to the experience of two marketing boards set up by two of the major meat (especially beef) exporting countries, Australia and New Zealand, and also that of an inter-trade body set up in France, ONIBEV; the functions of these bodies are defined by law and are financed by parafiscal taxes. It was shown that the marketing boards are much more effective in the export sector than in improving the efficiency of the beef chain within the country, and that a body such as ONIBEV, which is still in the experimental stage, can, despite more limited powers than those of the export boards, play an important role since it constitutes a structure for coopera-

FIGURE 2. *Intensive fattening*

FIGURE 3. *Carcasses in store*

FIGURE 4. *Centralized cutting of carcasses*

FIGURE 5. *Supermarket display of vacuum-packed meat*

tion, permitting effective psychological action.

Lessons which may be useful to countries outside the OECD area

The study has shown the importance of a global approach to the structure and working of the whole marketing system. It is necessary tc ensure adequate dovetailing of the different elements of the system, this being the only way to guarantee efficiency.

As has already been pointed out for the marketing of cattle and meat, the OECD countries have adopted an open and decentralized market system based on the price of the product, a system implying very moderate government intervention. At the other extreme the alternative would be a highly concentrated and centralized system with considerable vertical integration. In fact, only a very limited number of OECD countries have turned toward certain forms of centralization and integration.

When a certain structure has been chosen, a number of measures must be applied to make it work. Even with the formula of the open decentralized market the government must:

- help to ensure market transparency and in particular determine where and by what method efficient price formation can take place;
- protect the system against any concentration of private power, either by limiting it or by ensuring that each power is counterbalanced by another.

Experience in the OECD countries shows that, notwithstanding considerable variations from one country to another, beef and veal are and will remain expensive products at least in countries with intensive production systems for fattening (essentially in Europe and the United States). The level of consumption will therefore be related not only to food habits, but also, in the industrialized societies or those in the process of industrialization, to the income of the population and to beef prices. To increase meat consumption, therefore, it will be necessary to practise a policy designed to increase income while keeping consumer prices as low as possible.

The problems of international trade were not studied exhaustively during the symposium as they have been analysed elsewhere. However, it seems clear that national policies and international agreements should be so framed as to make possible the optimum allocation of resources at international level and so favour the development of beef consumption.

Beef and veal are moreover products with a low level of value added — at least as far as fresh meat is concerned. The producer's share in the price of beef paid by the consumer is thus in the region of 65 to 75 percent; hence the need to improve efficiency at all stages in the chain, including production, in order to maintain consumer prices.

It should be added that if satisfactory results are not achieved, other meats and other animal, vegetable or synthetic proteins will compete with beef. This development has already been noted in the United States, where textured vegetable proteins extracted from soya beans are mixed with minced beef in the making of hamburgers, notably when the price of beef reaches a particularly high level.

In the retail trade trend toward modern forms of marketing has not eliminated the more traditional forms. In the United States supermarkets have acquired a dominant position, but in most other countries they coexist with traditional butcher shops. It seems desirable that the two forms should coexist, but their development should be facilitated by carefully thought out measures.

The public authorities must also show concern for the consumer. It is essential to enable him to play his full role, and to provide for his training, information and representation in all bodies which are important for the production, processing and marketing of meat.

Plans exist in many countries for the development and modernization of slaughterhouses. Such plans have not always been successful and have sometimes led to considerable waste, and too large, badly located slaughterhouses have been built without taking into account changes in marketing structures. The OECD study points to the need to build slaughterhouses in the production regions, on condition that the communications network and transport facilities are adequate. It would also be desirable in many cases to opt for medium capacities in the region of 10 000 to 20 000 tons per year and to provide for flexible formulas whereby cutting facilities would either be attached to slaughterhouses or provided separately in large central plants.

Provision should be made as soon as possible for the financial autonomy and independent management of producer groups. They should be subject to the same laws as the non-cooperative sector, and should be economically viable. The coexistence of the cooperative and non-cooperative sectors seems desirable. Moderate support for cooperatives and groups should facilitate an adequate balance between the two sectors.

The search for efficiency at all stages of the chain should permit better advance knowledge of demand and a certain adjustment of supply. Such adjustment raises a number of technical and economic problems. The reduction of slaughter costs, for example, depends to a large extent on regular supplies to the slaughterhouses over time. But in many countries, and in particular those with extensive production systems, production is highly seasonal, and staggering would lead to a substantial increase in the costs of livestock production. A compromise must therefore be found between the requirements of the different elements in the chain.

Since the beginning of the present decade production cycles have tended to become more marked in the beef sector and to be synchronized at international level as a result of a large number of factors. Regulatory mechanisms are necessary in the short term, while the implementation of policies in respect of livestock production and consumption is necessary in the long term. Improved efficiency of the beef chain should facilitate the implementation of these mechanisms and policies. It has become increasingly evident that all these problems must be considered not only at national level but also at international level.

Interpreting the results of dairy bull progeny testing by artificial insemination

2. Present methods of analyzing daughter records

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Throughout the world new problems are being recognized in the evaluation of dairy bulls. The first part of this article (published in *World Animal Review*, No. 22) outlined in detail the factors that affect accuracy of evaluation and the analytical methods needed. In general, it has been recognized for some time that herd, year and season are major factors contributing to possible biases in interpreting the results of dairy bull progeny testing by AI. Age at calving also has an influence on yield and is often different among progeny groups. The most difficult problem, however, in evaluating progeny records is the genetic difference that has developed between years and herds within years. Associated with this is the possibility that within herds some bulls may be mated to the better cows. Likewise, genetic components in the yield-age relationship are accentuated by the emphasis on only first lactation yield in evaluating daughter producing ability.

Interpretation of progeny records

The original methods for interpreting progeny records were called "contemporary comparisons" or "herdmate comparisons," the two methods differing essentially in that the latter used all herd records while the former was restricted to first lactations. These methods are still in use in many countries but active consideration is being given to the use of Best Linear Unbiased Prediction (BLUP) methods described by Henderson (1973). Many abbreviated BLUP procedures are already in use, as described below.

Cumulative Difference (CD)

Bar-Anan and Sacks (1974) extended the use of the contemporary comparison procedure to account for differences in genetic value of sires of cows that are contemporary to daughters of bulls being evaluated. The final evaluation after accounting for the genetic value of sires of contemporaries is called the Cumulative Difference (CD) and eliminates the genetic time trend bias that exists in the contemporary comparison evaluation. Applied to the system for progeny testing bulls in Israel, this evaluation technique has resulted in an estimated annual increase of 72.4 kg of fat-corrected milk per lactation. This procedure cannot be regarded as unbiased because bulls never receive a single evaluation on all daughters with the appropriate heritability regression applied.

Improved Contemporary Comparison (ICC)

The Milk Marketing Board of England and Wales (MMB) has recently adopted an abbreviated procedure very similar to the CD method in principale but more sophisticated mathematically. The ICC method is based on separating sires used extensively (daughters in 10 or more herds per season) from those of limited use (all other sires). A weighted least squares procedure is used to estimate sire effects in the group of bulls used extensively, and these evaluations are used to adjust the records of cows with which daughters of the limited-use sires are compared. Biases can occur, as in the CD method, because all bulls are not evaluated simultaneously. Therefore the distribution of daughters of bulls over years and over herds within years in both the ICC and CD methods could affect individual evaluations.

Modified Contemporary Comparison (MCC)

Dickinson *et al.* (1974) describe the most complex procedure now in use. It is basically very similar to the New Zealand method which has been in use since 1963 (New Zealand Dairy Board, 1973). This method uses all lactation records (herdmate comparison) and pedigree performance of a bull's sire and maternal grandsire, as well as the average estimated genetic value (EGV) of herdmates. A heritability regression apportions emphasis on pedigree and progeny data by (1-R) and R respectively, i.e. as the number of daughter records increases R increases and emphasis on pedigree decreases. The use of this method since 1963 in the bull breeding programme in New Zealand has resulted in an estimated increase per cow of 24.5 lb of butterfat in all herds and of 50 lb in artificially bred herds up to 1974-75.

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The AI Industry has made major capital investments to provide the breeding service needed by modern dairymen. This aerial view of an AI Cooperative in the U.S.A. shows the office and laboratory building and the bull barns. At another location there are facilities for holding young bulls inactive until their progeny tests become available to determine which will be returned to service as proven bulls.

The national sire analysis in the U.S. (MCC) is probably the most complex approximate system now in use, being an improvement over the NZ system in that the initial sire evaluations, based on herd averages corrected for contemporary sire values, are successively improved in accuracy by an iterative procedure. Each new round of iteration provides better estimates of genetic levels of herd performance which then provide better sire estimates. When several rounds of iteration are used, little change is observed in the sire estimates with additional iteration; the process is then stopped and the final value accepted.

The sire values are used to give cow indexing a sire and maternal grandsire adjustment. Cow records are separated into first lactations and second and later lactations, with deviations for each record obtained from the appropriate parity herd average. This is an attempt to allow for culling effects among cows.

Grouping of sires is done by pedigree estimates of the breeding value of sires and maternal grandsires of all sires to be evaluated. These pedigree estimates form genetic groupings to which the sire effects are regressed by heritability of the estimates. Simulation studies have shown this U.S. method to be effective in removing genetic time trends from both sire and cow evaluations, and estimates on young bulls from pedigree analysis ensure early evaluation of new introductions by AI units.

The question arises, however, which is the best method. Little research has been done on correlating sire evaluations from different methods applied to the same data. Unpublished correlations from Canadian data indicate relatively high correlations between different forms of direct sire comparison methods (BLUP) but low correlations between these and the former herdmate or contemporary comparison methods.

BLUP and the North Eastern Sire Comparison (NESC)

The mathematically most rigorous approach to evaluating sires from progeny records was presented by Henderson (1974) and resulted in the application of the NESC technique (Everett, 1974). This satisfies the statistical concept of Best Linear Unbiased Prediction (BLUP) and simultaneously estimates sire, time and herd effects. Henderson (1973) demonstrated the practical and theoretical soundness of this technique which has the desired property of jointly estimating genetic effects as random variables, with adjustment for herd and time effects as fixed variables.

The NESC technique uses only first lactation records on AI bulls, but computer programmes have been written to include natural service sires and cow indexing. Computer time for applying the most complete model to large amounts of data is the only drawback to general application of BLUP analysis. Chesnais *et al.* (1975) have demonstrated, by use of new programming strategy and techniques, a substantial reduction in computer time for Canadian sire evaluation which uses natural service sires as random variables to improve the accuracy of evaluating AI sires. Because of a new major contribution by Henderson (1975) the genetic relationship between AI sires is now used as an integral feature of BLUP analysis, assisting considerably the evaluation of young sires with few daughters that have proven sires or more distantly related proven males.

Although these most advanced techniques give unbiased estimates, they are very demanding as to suitability of data. They will not overcome selection bias in sire evaluation or

culling bias in cow evaluation unless all records are included for one overall analysis; that is, when cow indexing is performed simultaneously with sire evaluation, first lactation records must be present. Likewise, all daughter records on bulls must be included to avoid evaluations using only daughters produced after selection on initial progeny performance. Consequently the new BLUP analyses have the distinct advantage of being able to eliminate culling and selection bias when no other method is capable of this for certain, but many years of data must be used. For example, in Canada 400 000 lactation records are now used in a BLUP first-lactation analysis, whereas for the previously used herdmate comparison procedure about 60 000 records per year updated the sire estimates. When cows are included in the model, 1 500 000 records will be processed at one time with an increase of 60 000 each year.

Controlled sire tests

Several countries have avoided mathematical complications of sire evaluation by establishing systematic bull breeding programmes in which a large number of bulls are selected yearly for progeny tests. Analysis of data applies separately to each set of annual progeny tests so that each bull effectively has only one progeny test and the annual rate of genetic improvement does not bias the bull rankings. Such programmes are concerned with growth rate as well as milk production, and about half of the original number of bulls tested annually are culled for low body weight at one year of age. In Bavaria, 500 bulls are tested each year; 210 selected on growth rate for test matings and further evaluation on daughter milk performance. From these 210 performance-tested bulls only 30 proven bulls are used heavily in the total cow population, and only the best 10 of these are used to sire another generation of 500 young bulls for another cycle of growth and progeny testing.

Similar programmes exist in Norway and Finland where selection for body size (weight at a fixed age) is applied to young bulls before a final group is chosen for test matings. Selection pressure through the male side of the pedigree assures genetic progress in size of daughters. Whether this gives a positive correlated response in level of milk production is doubtful from studies on the relationship between body size and milk production (Hickman and Bowden, 1971).

Most AI units do not provide for the raising of their bulls from calfhood, but scientific investigations are in progress to study possible relationships between bull traits during growth and future production of daughters. Regardless of the prior selection of bulls before progeny arrive, the interpretation of results is the same, and the original contemporary comparison method is unbiased when applied to first lactation daughters of sires all born in the same year. To be certain that bulls selected from one year group have superior breeding value to those selected from the previous group requires estimates of genetic change in the population (Hickman and Freeman, 1969). However, the genetic reliability of these extensive bull breeding programmes assures that each successive group of bulls is superior.

Analysis of dairy records for all aspects of breeding, feeding and management can progress only to the point where data processing equipment is available at reasonable cost. Improvements over present methods are not limited by technical knowledge but by programming competence to use fully computer capability in dairy industries. This review of different methods and prospects may stimulate an interchange of techniques to help achieve the common goal of maximum profitability of daughter production. Several countries are still using the original contemporary comparison or herdmate comparison procedures which are now widely recognized as inadequate for modern AI breeding; in fact, Cunningham (1965) provided early warning of the need for methods requiring large computer capability. Now that the basic techniques are known and computers are becoming more widely available changes in procedures are occurring regularly, but it is impossible to know at any particular moment the details of methods in use. Hopefully, too much time in the change-over process will not be wasted by the lack of communication between those developing new programmes and those developing programming techniques.

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use of whey in feeding ruminants

with particular reference to pollution problems

Pierre Thivend

Whey is a slightly acid, yellow-green liquid which is the residue obtained from the coagulation of milk by rennet or by the lowering of its pH. A considerable volume of whey is produced in the world, and it has continued to increase in recent years (Table 1). In 1973 France, the world's second largest producer after the United States, produced 6 million metric tons of whey, of which about 20 percent was wasted.

Whey is a strong pollutant when discharged into streams, its high organic matter content leading to a biochemical oxygen demand (BOD5) ranging from 30 to 40 g of oxygen per litre. As a result, the pollution load from a cheese factory processing 100 000 litres of milk per day would be equivalent to the pollution of a city of 60 000 inhabitants (Petillot, 1976). Given the large quantity of whey produced worldwide each year, the risks of pollution are therefore extremely high.

There are various methods of utilizing or disposing of whey. It can be dumped at the production site, provided that the land area is large enough and the soil permits the absorption of the mineral elements and the organic matter. The principal constituents of whey can also be separated either by precipitation or by passing through an ultrafilter. The resulting proteins can be utilized for the manufacture of certain types of cheese; the lactose obtained by the crystallization of the raw or concentrated product could be utilized for human food or by the pharmaceutical industry. Whey is also an excellent substrate for the cultivation of yeasts; there are various procedures which make it possible to obtain large quantities of protein, lactic acid, ethyl alcohol and vitamins by this technique.

However, animal feed is by far the principal outlet for whey. It has been used in liquid form, principally for pigs, when the available quantity was not large and could be used nearby, but for practical reasons of transport and storage this pattern of use has been progressively superseded by drying for animal feed. This involves increased production costs which limit its use to the feeding of young animals (calves or young pigs) or fattening pigs.

With the growth of the cheese-making industry the increasingly larger quantities of non-utilized whey have resulted in greater pollution hazards, but the organization of a pollution abatement campaign and better knowledge of the nutritional value of whey have led to a search for new ways of disposing of this by-product. Among the different solutions proposed, the utilization of whey in feeds for ruminants constitutes one of the newest and most rapidly exploitable means that may be adopted in the future. It is inexpensive, easy to put into practice, and offers a good method of utilizing nonprotein nitrogen sources

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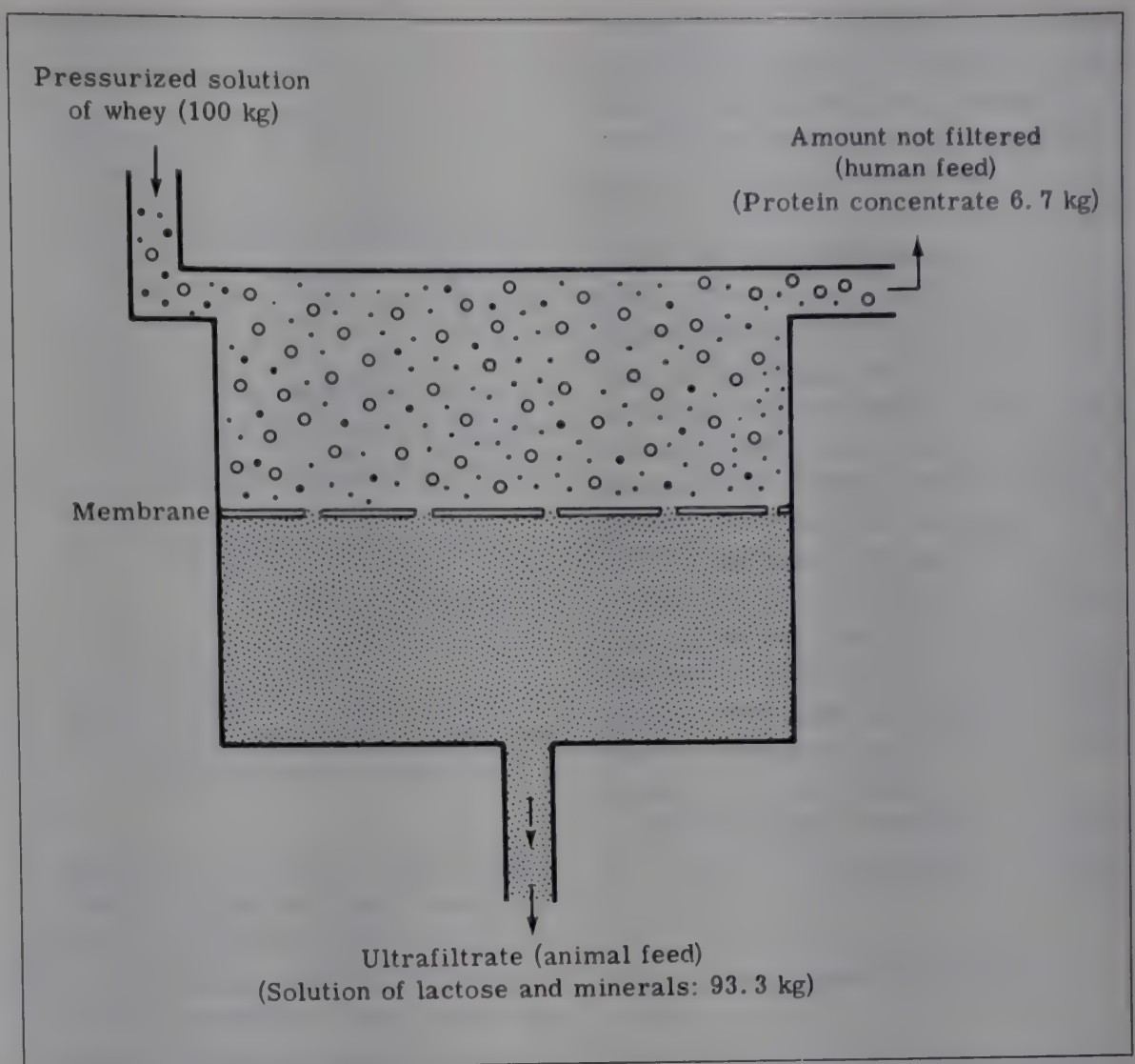
suitable for ruminants. The techniques for limiting the pollution resulting from surplus whey production are discussed below.

Composition of whey

The dry matter content of whey is very low (6.0 to 7.5%). It is composed essentially of lactose (70 to 73%), protein (N × 6.25 = 12 to 13%) and mineral salts (7 to 11%). It also contains lactic acid in variable quantity (0.5 to 10%), citric acid (about 1%) and some nonprotein nitrogen (0.5 to 0.8%).

The composition of whey varies essentially with the type of cheese of which it is a by-product; sweet whey comes from the production of cooked or pressed cheese curd, while acid or sour whey, which is richer in lactic acid and minerals, is a by-product of fresh cheeses. The composition also varies with the method of preservation and with the origin of the milk.

Whey proteins (lactoalbumins and globulins) are of excellent quality; their essential amino acid content is superior to that of egg or casein proteins. They are quite rich in lysine and tryptophane and in the sulphur-containing amino acids (methionine and cystine). Whey is also relatively rich in calcium, phosphorus, sodium, potassium and chlorine. The concentration of these last three elements in whey is constant irrespective of the origin of the product, but the calcium and phosphorus concentrations are greater in sour than in sweet whey.



Source: Maubois (1974).

FIGURE 1. *Ultrafiltration of whey separates high-quality proteins which could be used in food for humans from the ultrafiltrate residue, which can provide an excellent and inexpensive ruminant feed.*

Digestion of whey

Schingoethe (1976) stipulated the maximum usable quantities of whey in the feeding of poultry, pigs, rats and ruminants. From these results and from more recent work done, particularly in France (Ehouinsou, 1976; Vermorel and Thivend, 1977), it is evident that adult ruminants are able to use much larger quantities of whey or derived products (ultrafiltrates) than other species. A considerable amount of research has been done on the digestion of these products.

In the rumen, lactose is broken down quite rapidly by bacteria and protozoa and converted into lactic acid, which is metabolized into volatile fatty acids, principally butyric acid. Under normal feeding conditions very little lactic acid is absorbed into the blood, but if the animals are given large quantities of lactose before the microbial population of the rumen has become adjusted to its use, severe fermentation problems may result. Lactic acid in excess penetrates the wall of the rumen and may cause serious metabolic disorders (acidosis).

Lactose is an energy source which makes possible the utilization of nonprotein nitrogen in the rumen. The ammonia concentration of the rumen fluid is not increased by the addition of urea to the ration, provided a proportionately large amount of lactose is combined with it (Thivend and Ehouinsou, 1977); the lactose/urea ratio should be around 5:1 or 6:1. The synthesis of microbial proteins in the rumen is improved by this process.

The digestibility of the nitrogenous matter in whey has been studied only to a very limited extent in adult ruminants. The nitrogen in the whey is converted in the rumen into microbial protein; its apparent digestibility is of the order of 70% (Anderson, 1975). When it is not degraded in the rumen, its digestibility in the intestine is much higher (91% in preruminant calves, according to Toullec *et al.*, 1974). It would therefore be more satisfactory if whey could by-pass rumen fermentation so that the proteins could be absorbed in the intestine, but this is usually difficult to realize in practice. In fact, these proteins should be reserved first and fore-

most for human food or for monogastric animals. Modern procedures of separation of the different whey constituents (ultrafiltration) will doubtless permit the attainment of this objective.

There is limited data on the digestive utilization of various whey minerals. According to Schingoethe and Rook (1976), the addition of 5% whey to a concentrate feed for dairy cows does not improve absorption or retention of the minerals in the ration. It is important to ascertain whether the use of a higher percentage of whey changes mineral nutrition in ruminants.

The digestibility of the dry matter of whey in ruminants is excellent and amounts to 87% when whey constitutes 30% of the total feed intake (Anderson, 1975). Its net energy value has not been determined but is probably close to that of barley.

TABLE 1. – **Estimates of world whey production**

Country	1966	1971	1973
	Thousand metric tons		
United States	8 618	10 883	11 836
France	4 878	5 603	6 136
U.S.S.R.	3 456	3 624	4 016
Italy	3 912	3 840	3 960
Germany, Fed. Rep. of	2 512	3 825	3 568
Other countries of the EEC	4 154	5 234	5 645
Other west European countries	4 649	5 083	5 232
East European countries	4 968	6 088	6 300
Australia and New Zealand	1 352	1 440	1 512
Developing countries	17 344	19 344	20 723
World production	57 113	66 190	70 695

Source: Krostitz and Zegarra (1975).

Methods of using whey

In liquid form

This is the least expensive method of feeding whey to animals when they are located close to the cheese processing plants. Various trials have shown that ruminants, both young and adult, are able to ingest very large quantities of fresh whey in partial or total substitution for drinking water; according to Anderson *et al.* (1974), dairy cows can drink as much as 100 litres per day, which corresponds to over 30% of the total dry matter intake. Under these circumstances no depressive effect on milk production, duration of lactation or butterfat content has been reported. Growing calves are also able to absorb very high quantities of liquid whey (from 40 to 50 litres per day, or 30 to 50% of the total dry matter intake), and it is estimated that ruminants can generally ingest from 12 to 15 litres of fresh whey per 100 kg live weight.

The intake of liquid whey reduces the amounts of hay or grain consumed, since substitution for grains on a dry matter basis can be virtually total. As a rule sour whey is found to be less palatable than sweet whey, so that it is desirable to provide fresh supplies daily. It is also necessary to ensure that the whey is free of any pathogenic organisms, and during hot weather particular care has to be taken over the cleanliness of feed distribution facilities to prevent both fermentation and an increase in the fly population. The increased urine excretion sometimes observed when large quantities of whey are consumed presents no danger to the animals; on the other hand, digestive disorders such as diarrhea or bloat may occur if the period allowed for adaptation to whey feeding is less than one week.

In concentrated form

Whey can be used in concentrated form, with a dry matter content ranging from 50 to 60%. If utilized by itself this product is not very palatable and usually rapid sedimentation occurs as a result of lactose crystallization. When it is mixed with molasses in equal proportions, dairy cows accept it readily (Welch, Nilson and Smith, 1974); when urea and minerals other than calcium (which for technological reasons cannot be added) are added the mixture can be used as a supplemental liquid nitrogen feed for ruminants. In the U.S.A. concentrated whey is sometimes used after it has undergone lactic fermentation and neutralization with ammonia (Henderson, Crikenberger and Reddy, 1974). The product obtained has a 7 to 10% nitrogen content and is used to supplement staple rations of ensiled maize for dairy cows or growing animals. It is very palatable and reportedly results in performance levels similar to those obtained by supplementation with urea or soybean oilcake.

In dried form (whey solids)

Whey in the form of dried solids can also be used by ruminants. When introduced in relatively moderate doses (14% of total dry matter) in concentrate feeds, it prevents the lowering of the butterfat content generally observed in dairy cattle when this type of feed is consumed in large quantities (Schingoethe, Stake and Owens, 1973), this phenomenon apparently being due to the presence of both lactose and minerals. If used in small quantities in the rations of fattening lambs or finishing steers, dried whey improves animal performance considerably (Larsen *et al.*, 1963; Woods and Burroughs, 1962). For calves that are being weaned, the introduction of whey at the rate of 10% of the concentrate feeds increases feed intake (Morrill and Dayton, 1974), but if whey is introduced at a rate higher than 20%, the concentrate feed intake decreases.

The high cost of whey drying and the technological difficulties of incor-

TABLE 2. – **Composition of different types of whey**

Type of origin	Whey		Sheep	Goats
	Sweet	Sour		
	Percentage of defatted extract			
Lactose	78.8	69.7	65.9	63.0
Protein nitrogen (N × 6.25)	13.7	11.7	23.7	14.7
Nonprotein nitrogen	0.6	0.8	1.0	1.1
Lactic acid	0.5	11.6	2.3	13.9
Citric acid	2.0	0.4	1.3	0.2
Minerals	8.0	11.3	7.3	13.4
Phosphorus	0.6	1.0	0.7	1.1
Calcium	0.7	1.9	0.6	2.1
Potassium	2.2	2.3	1.7	2.9
Sodium	0.8	0.8	0.8	0.7
Chlorine	3.3	3.2	3.1	5.3

Source: Collet and Février (1975).

poration of the powder in concentrate feeds have limited the use of dried whey in feeds for adult ruminants. Apart from the trials of Huber, Polan and Rosser (1967), in which whey constituted 50% of the dry matter intake of dairy cows, no other data are available on the use of large quantities of whey over long periods. However, the work of French researchers who used the ultrafiltrate of dried whey (Thivend, 1977) shows that ruminants can consume very large quantities of lactose (up to 72% of the dry matter) without exhibiting digestive disorders. This source of energy could well replace a large part of the cereals in fattening rations for ruminants (Table 3) and enhance the use of nonprotein nitrogen by the rumen microflora.

At present dried whey is used primarily for feeding young calves. A considerable volume of research (Schingoethe, 1976) has shown that it could supply most, or even all, of the lactose in calf feeds from 6 to 8 weeks before weaning. In the case of veal calves which are fed exclusively on milk for longer periods (3 to 4 months), the proportion of whey used does not usually exceed 15% of the dry matter because of the large quantity of skim milk powder already included in their feeds. However, Toullec *et al.* (1974) have shown that it is possible to produce veal calves weighing about 160 kg by using feeds in which the lactose and protein is provided solely by whey. Similarly, lactose can also be supplied exclusively by the ultrafiltrate of whey (Toullec *et al.*, 1976).

Whey can also be used to improve the preservation and quality of silage, particularly that made from forage with a low content of rapidly fermentable carbohydrates. The addition of a small quantity of whey (2% of the total dry matter content) to grass or maize silage in dried, concentrated or liquid form improves the digestibility of the main constituents of the mixture (Schingoethe, 1976). Ammonia nitrogen losses are reduced and the silage is made more palatable; moreover, beneficial effects are reflected in the performance of the animals (Schingoethe and Beardsley, 1975).

TABLE 3. – **Utilization of dry whey ultrafiltrate for finishing steers**

	Group I	Group II	Group III
Feed composition			
Ground maize	50	25	0
Dry ultrafiltrate	0	25	50
Soybean oilcake	10	12.5	15
Coarse bran	14.5	22.5	30
Beet pulp	19	9.5	0
Ground straw	0	1.5	3
Molasses	5	2	0
Mineral and vitamin premix	1.5	2.0	2
Animal production			
Number of animals	10	11	12
Dry matter intake (kg/day)	7.76	7.66	7.79
Average daily gain (g)	1 283	1 254	1 149
Feed conversion rate:			
kg dry matter intake per kg of gain	6.05	6.11	6.78
net energy (F.U.) intake per kg of gain	6.74	6.38	6.69

Source: Vermorel and Thivend (1977).

Possible utilization of whey

Whey is one source of energy and nitrogen that is very well utilized by both preruminants and ruminants. Moreover, insofar as ruminants are concerned, the presence of lactose in the ration improves the use of nonprotein nitrogen. The beneficial effects of whey in ruminant feeding have now been fully demonstrated, provided that certain rules for its use are followed:

— The microbial population in the rumen should be allowed to adapt itself to the fermentation of lactose by gradually increasing the amount of whey used over a period of at least one week.

- The bacteriological properties of the feed should be carefully observed, especially when the whey is given in liquid form.

- The ration has to be balanced, care being taken to avoid the simultaneous use of whey and other feeds that may produce an excess of lactic acid, such as beets, cabbage and certain types of silage.

- The mineral imbalance that may result from considerably prolonged periods of whey feeding, especially in dairy cows, must be corrected.

If such precautions are taken, the feeding of whey to ruminants would be a very useful outlet for this product and would limit to the minimum possible the pollution caused by whey.

The dried form of whey (whey solids) is generally too costly except when it is used to replace the skim milk powder usually incorporated in the manufacture of feeds for young ruminant calves. Liquid whey or concentrated whey will probably come into greater use when regular supplies can be assured and when the animals are located close to where the whey is produced; also, because they are highly fermentable products, climatic conditions would affect their possible use.

Conclusion

The use of whey in ruminant feeding could result in an inefficient utilization of the protein that it contains, unless modern techniques for the separation of whey proteins are more universally adopted. Ultrafiltration of whey, for instance, makes it possible to separate the proteins, which are of excellent quality and could be utilized as food for human beings, from the ultrafiltrate residue, which is composed essentially of lactose and minerals (Fig. 1). The ultrafiltrate can be used by ruminants either alone or in combination with nonprotein nitrogen and would provide an inexpensive liquid or concentrate feed (Thivend, 1977).

Ultrafiltration of whey should make it possible to recover an appreciable quantity of proteins for human food, to supply ruminant feeds which, if supplemented with urea, could replace grain, and at the same time to reduce considerably the pollution caused by the dairy industry.

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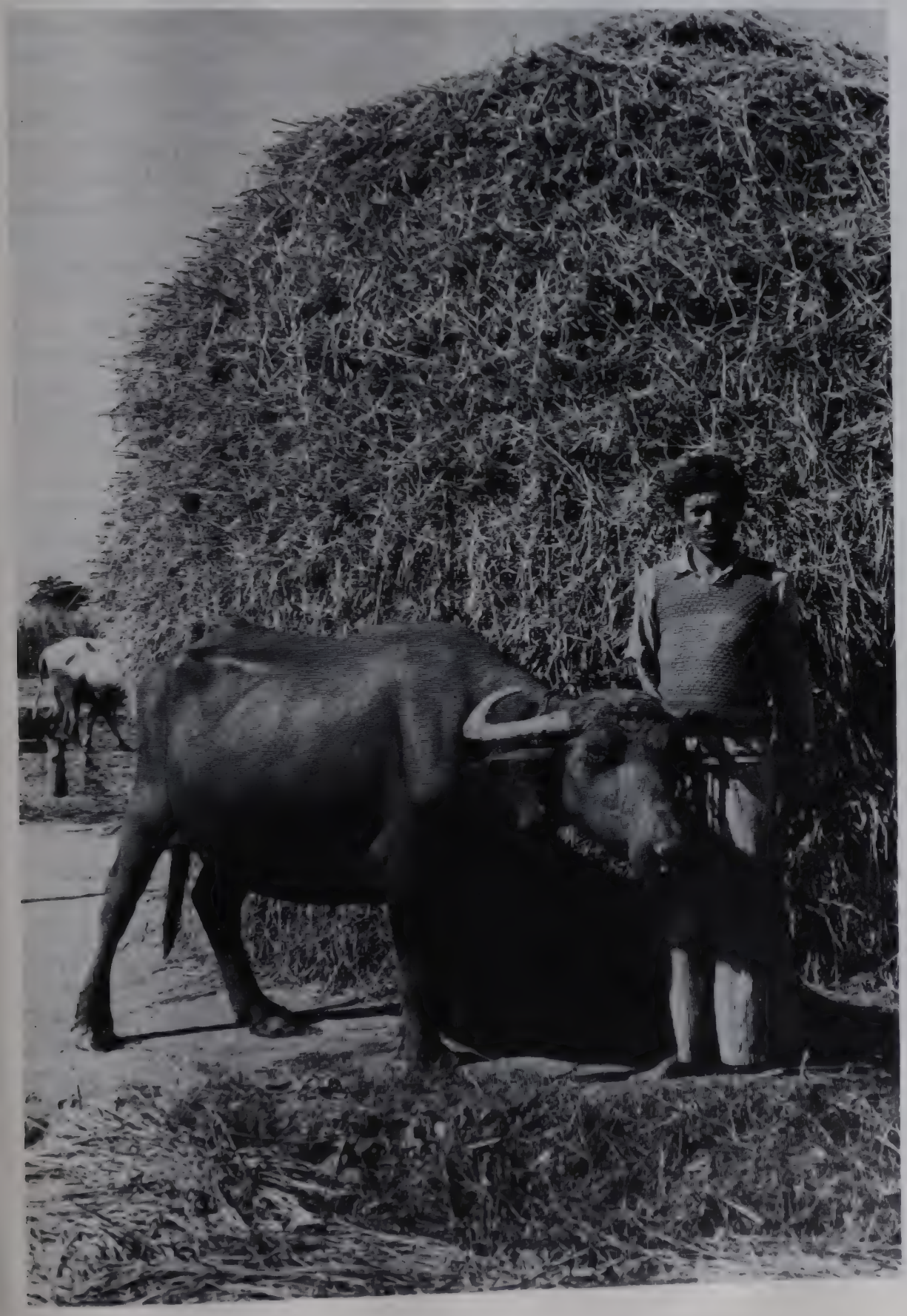
rice straw
as livestock feed

FIGURE 1. *Rice straw neatly stacked. The buffalo will convert it into milk. The same stack of straw would produce more milk if the straw were alkali-treated and supplemented with urea and minerals.*



M.G. Jackson

The annual world production of cereal straws and stovers is approximately 2 000 million tons, however, the energy contained in this vast bulk of material is on the whole poorly utilized and its nitrogen incompletely returned to the soil. With the rising prices of both energy and nitrogen fertilizer, interest is developing in more efficient ways of utilizing straws, presently used mainly as livestock feed and as compost material (small amounts are used for the manufacture of paper and fibreboards). In the tropical and subtropical areas of the world almost all straw is fed to livestock, the resulting dung being widely used as fuel. With straw feeding, energy utilization is relatively efficient, except for the residual energy in the indigestible matter which is wasted, but the introduction of dung fermentation in place of dung burning increases the proportion of straw nitrogen which is returned to the soil, thus improving the overall efficiency.

In temperate countries the practice of ploughing down straw directly or after using it as bedding returns most of the nitrogen to the soil but wastes all the energy; the same applies to composting, which is done on a large scale in China. Straw burning is practised particularly where crop rotations do not allow sufficient time for ploughed-in straw to decompose, and where livestock enterprises that could use the straw have not been developed. Burning means, of course,

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FIGURE 2. *Cows eating chaffed rice straw. This is the most efficient way at present to recover the energy of straw. Straw nitrogen can also be effectively recovered if the dung is subsequently fermented to produce gas.*

a complete waste of organic matter, and this, in addition, pollutes the atmosphere.

Improving the efficiency of straw-fed livestock

The utilization of straw through feeding and through the production of gas from the resulting dung is the most efficient system currently available. However, the efficiency of the livestock component could be considerably enhanced by applying presently known techniques, so that more animal products could be obtained from given quantities of straw than at present. The purpose of this article is to describe how this can be done with particular reference to rice straw. Mention will also be made of how rice straw may be used to advantage in intensive systems of livestock production prevalent in those countries where cereals, molasses and oilcakes are available in abundance and rice straw is at present burned or otherwise wasted.

In south and east Asia the rice farmer cultivates at most only a few hectares of land. Tillage operations are done by cattle or buffaloes and the remaining operations by hand, the ripe paddy crop being cut at ground level with sickles and hand threshed. In this process all the straw is recovered, then stored in stacks, which are thatched if necessary, and fed to livestock. To consume the straw obtained from a one-hectare crop of rice during the course of a year, one animal is needed; two are needed if two crops are grown. Thus cattle and buffalo populations are high in most of the rice-growing countries of Asia. Animal productivity is low because of the poor nutritive value of rice straw and the very limited amounts of supplementary feeds available. The average availability of cereal and pulse milling offals and oilcakes per head of cattle or buffalo in the rice-growing areas of India is only about 0.1 kg per day; green grass and forage are equally scarce. However, as mentioned above, livestock productivity can be increased, even in the face of limited supplies of supplementary feeds, by the use of urea and mineral supplements and by the alkali treatment of straw.

Nutrient deficiencies of rice straw

Straws are a poor livestock feed, and rice straw is no exception. It contains about 80 percent of substances which are potentially digestible and are therefore sources of energy, but actual digestibility by ruminants is only 45 to 50 percent. Furthermore, the amount an animal can eat is limited to less than 2 percent of body weight because of the slow rate at which it is fermented in the rumen. The net result is an energy intake which provides little or no surplus energy for growth, work or production. The most important consideration in ob-

taining more animal products from straw in the Asian setting is to improve digestibility and intake so that more energy is available for productive purposes. Protein supplements increase intake, while the alkali treatment of straws increases digestibility and usually voluntary intake as well. The chemistry of straw and its digestion and the chemical changes caused by alkali treatment are receiving increasing attention from animal nutritionists (Jackson, 1977).

Straws contain only 3 to 5 percent crude protein. Animals on an unsupplemented straw diet will usually not gain any weight and very often will actually lose weight. To obtain any production the straw must be supplemented, preferably with both nitrogen/protein and energy. For good growth on straw diets, a level of 8 to 10 percent protein is needed for young stock; this also improves consumption and thus increases energy intake.

The level of phosphorus in rice straw (0.02 to 0.16 percent) is less than the level of about 0.3 percent that animals need for growth and normal fertility. A level of about 0.4 percent of calcium in the diet is usually considered adequate for livestock, and many samples of rice straw have this amount, the range being from 0.25 to 0.55 percent. Nevertheless, many balance experiments with cattle fed rice straw have shown negative balances of calcium even when the calcium content of the straw was apparently adequate (Nath *et al.*, 1969). While the significance of these negative calcium balances has been questioned (Negi, 1971), the fact remains that in the same experiment higher positive calcium balances have been observed on wheat straw and sorghum stover diets than on rice straw diets, even though the calcium intake on the rice straw diets was higher (Joshi and Talapatra, 1968). It would therefore seem prudent to feed a calcium supplement with rice straw diets.

Sub-optimal cobalt contents in rice straws from Assam and Orissa have been reported (Dube, 1964), and areas of copper deficiency are widespread in India and occur in a number of rice-growing areas. Thus the routine provision of supplements containing at least these two trace minerals would seem to be warranted.

Rice straw differs from other straws in having a higher content of silica (12-16 vs. 3-5 percent) and a lower content of lignin (6-7 vs. 10-12 percent). Whereas in all other straws lignin is the chief cause of low digestibility, in rice straw it is silica. Rice straw stems are more digestible than leaves because their silica content is lower; therefore the paddy crop should be cut as close to the ground as possible if the straw is to be fed to livestock. Thirty percent of rice straw silica is dissolved in the digestive tract, absorbed as silicic acid and excreted in the urine. The concentration of silicic acid in urine far exceeds its solubility limit, and thus it polymerizes into large insoluble molecular aggregates. With some species of grass

FIGURE 3. *A pelleted, alkali spray-treated straw diet. Such diets, containing 50 to 90 percent treated straw, can be designed for a variety of livestock production situations. Pellets are easier and cheaper to transport and store than the straw from which they are made.*

containing 4-5 percent silica, silicious urinary calculi are commonly formed in sheep and cattle. Though rice straw contains nearly three times more silica than any of these grasses, urinary calculi are not, in general, a serious problem. When they occur in stock fed rice straw they are probably made up of carbonates and bicarbonates (Talapatra *et al.*, 1948).

Rice straw also differs from other straws in having a high (1-2 percent) content of oxalates. These are broken down in the rumen to carbonates and bicarbonates, absorbed, and then excreted in the urine. The pH of water extracts of rice straw is about 8 and that of urine from stock fed rice straw as high as 9. The high oxalate content has been implicated in the greater need for calcium supplementation (Talapatra *et al.*, 1948). Water washing removes 30-40 percent of the oxalates and substantially reduces urine pH and titratable alkalinity; calcium balance is also improved. Washing also removes adhering soil, which is considerable, but to be weighed against these benefits is the loss of soluble nutrients, equal to about 10 percent of the original weight of straw.

FIGURE 4. *On mechanized farms rice is combine-harvested and the straw is left in the field to be burned.*

Urea and mineral supplements

Though rice straw has many limitations as a feed, it is no worse, in general, than other straws. Digestibility determined both *in vitro* and *in vivo* is as good as for other straws and in experiments both wheat and rice straw diets, properly supplemented, have equal body weight gains in growing stock.

Cattle fed a diet of rice straw, supplemented in the usual way in the rice-growing areas of India, grow very slowly (as little as 0.05 to 0.10 kg body weight gain per day) and mature late (4 to 5 years old at first calving). Subsequent fertility is also extremely low, rickets and anaemia are common, and animal production from a one-hectare rice crop is only the draught power needed to cultivate it plus 200 to 300 litres of milk per years. These figures are, of course, averages. Farmers with larger land holdings feed more than the average amount of supplements, those with smaller farms less. During the dry season growth may stop or animals may even lose weight, while during the monsoon they gain fairly rapidly because of the green grass and weeds available. An improvement in the nutrition of the small farmers' animals, particularly during the dry season, should thus be the primary objective.

A diet of rice straw alone is not adequate even to maintain animals, which will lose weight if no supplementary protein is given (Table 1). This is true of all straws and roughages containing less than about 4 percent protein, since a level of approximately 6 percent in the diet is needed to prevent weight loss. Alternatively, a supplement of urea at a rate of 1 percent of the straw fed will raise its nitrogen content to a level about equal

with the protein supplement. As has been shown in southern Africa with stock on mature veld grass during the dry season (Topps, 1972), this alone can considerably boost animal productivity in terms of time taken to reach maturity and subsequent fertility in females.[1]

Raleigh and Wallace (1963) obtained good growth responses in cattle when they supplemented mature meadow grass hay containing 5.5 percent protein with 1.6 percent urea.

The need for supplementary calcium and phosphorus has already been indicated; from the results of various experiments about 10 g of supplementary calcium and 5 g of phosphorus would appear to be needed. In areas where specific information on possible trace mineral deficiencies is not available, it would be prudent to give a complete trace mineral supplement; 30 to 50 g of common salt per head/day should also be fed. These mineral supplements will be of use only if a nitrogen/protein supplement is provided.

FIGURE 5. *Farm-scale alkali spray treatment of chaffed rice straw. A 5 percent solution of NaOH is sprinkled on at the rate of 1 litre/kg straw.*

Alkali spray treatment

The alkali spray treatment of straws has been shown to improve digestibility and intake (see review by Jackson, 1977). The straw is sprayed or sprinkled with a dilute solution of NaOH at the rate of 1 litre/kg, and the moist straw is immediately fed to animals. The optimum concentration of the NaOH solution appears to be about 5 percent where straw is to be fed with limited supplements, although where treated straw forms only about 50 percent of the diet, 7-8 percent appears to be better. All straws respond about equally to treatment, and an example of the benefits of alkali spraying of wheat straw is given in Table 2. If a smaller volume of a more concentrated alkali solution is applied with a pressure sprayer, the treated straw, along with supplements, may be pelleted. An example of animal performance on pelletted rice straw diets with or without treatment of the straw is given in Table 3.

The grinding and pelletting of poor quality roughages is known to increase intake. Whether the separate effects of alkali treatment and grinding and pelleting are additive has not been established. It seems likely that the high temperature and pressure combination to which treated straw is subjected in the pelleting process enhances the effectiveness of alkali.

The factory-scale processing of rice straw into pelleted complete diets containing 60 to 80 percent straw appears to have good prospects in Asia, where large numbers of milch animals are kept in or near cities and feed is transported from the surrounding country side. Factories for this purpose have already been designed (Rexen and Vestergaard Thomsen, 1976).

[1] From the results of these experiments it has been concluded that the feeding of small quantities of cereal or molasses supplements along with urea does not usually give any additional benefit.

The need for a protein supplement with alkali-treated straw requires special comment. Donefer (1968) found that treated straw, when fed without urea, was worse than untreated straw, primarily because intake was severely depressed; on the other hand, a very marked additive effect of treatment and urea was noted. His data are from an intake and digestibility experiment with sheep, whereas only one limited observation on growing cattle is known to have been made so far; Naik (private communication) obtained 0-17 kg live weight gain per head per day with 50 kg calves fed treated rice straw and 1 percent urea. A more efficient use of urea supplement with the treated straw is probably achieved because of the faster rate at which the treated straw is fermented in the rumen.

Rice straw for intensively fed livestock

Even where livestock are kept to convert cereals, molasses, oilcakes and high-quality grass into animal products, straw has a role to play. In experiments in the U.S.A. finishing diets for beef cattle containing 20 percent rice straw and 80 percent concentrates were found to give better results than those containing 100 percent concentrates (White and Reynolds, 1969). The rice straw stimulated intake, and ground rice straw was better than either the long or pelleted forms; fineness of grinding was not important (White, Reynolds and Hembry, 1971). Veitia, Esquivel and Simon (1971) experimented in Brazil with the liquid molasses feeding system developed in Cuba (see Preston, 1972). They fed 2-year-old zebu bulls *ad libitum* on molasses containing 3 percent urea, rice straw at the rate of 1 percent of body weight, bone meal, salt, and 1 kg of a high-protein concentrate. The bulls gained 0.91 kg/head/day and were slaughtered at 440 kg.

Terry, Spooner and Osbourn (1975) have shown how alkali spray-treated straw may be used to extend the supply of high-quality grass silage (Table 4). This should have an application in some rice-growing areas as well.

TABLE 1. – **Growth rate of cattle fed urea-supplemented and unsupplemented rice straw**

	Crude protein content (%)	Dry-matter intake (% of body weight)	Dry-matter digestibility (%)	Body weight gain (kg/day)
Straw alone	3.2	1.8	52	−0.12
Straw + urea	6.0	2.2	56	−0.01

Source: Rekib *et al.* (1970).
Note: Ten percent molasses was mixed with the straw along with the urea. All animals were given 1 kg of fresh berseem forage daily. Animals weighed 200 kg at the start of the experiment.

In addition to the above, rice straw can be used, with protein and mineral supplements, to carry breeding herds over the dry season. Factory-processed pelleted rice straw diets could be designed to rear beef and dairy calves economically. Treated straw (7-8 kg NaOH/100 kg) could be incorporated in such diets at levels of 50-70 percent.

FIGURE 6. *Rice hand-harvested at ground level to be used as livestock feed.*

Summary

Feeding livestock appears at present to be the best use to be made of straws. In the tropics the subsequent fermentation of the resulting dung would improve still further the recovery of energy and nitrogen from the straw.

In many of the intensive rice-growing areas of Asia all straw is even now fed to livestock, though it is not efficiently used by them owing to the scarcity of supplementary feeds. Urea, minerals and alkali spray treatment could boost efficiency greatly.

In other parts of Asia, in the Americas, and perhaps in some other areas as well, a large proportion of the rice straw produced is not fed to livestock. The possibilities of feeding it in any of the ways described in this article should be seriously considered, the most appropriate way in any particular situation depending on what other feeds are available and in what quantities.

TABLE 2. – **Animal performance on alkali-spray treated and untreated wheat straw diets**

	Untreated straw	Treated straw
	Kg/head/day	
Gain	0.25	0.42
Intake:		
straw	4.5	6.0
groundnut cake	0.83	0.97

Source: Singh *et al.* (1975).

Note: The experiment was done on Sahiwal-Jersey crossbred calves weighing 70 kg. Straw was treated with 3.3 kg NaOH/100 kg straw. Groundnut cake was individually fed according to weight.

TABLE 3. – **Animal performance on alkali spray-treated and untreated pelleted rice straw diets**

	Untreated straw	Treated straw
	Kg/head/day	
Gain	0.23	0.71
Feed intake	8.1	11.4

Source: Garret *et al.* (1976).

Note: The experiment was done on 290-kg steers. Straw constituted 72% of the total diet and was treated with 4 kg NaOH/100 kg straw.

TABLE 4. – **Animal performance on grass silage and a mixture of silage and alkali spray-treated barley straw**

	Silage only	Silage straw mixture
	Kg/head/day	
Gain	0.44	0.42
	G DM/kg live weight	
Intake	19	23

Source: Terry *et al.* (1975).

Note: The experiment was done on silage with a dry-matter digestibility of 77%. It was mixed with straw in a ratio of 54 to 46 on a dry-matter basis. Straw was treated with 7 kg NaOH/100 kg.

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beef production in Tunisia

an example of a development project

J.M. Hall

As in the other Maghreb countries, agriculture in Tunisia was deeply marked by the colonial experience which determined its structures and, to a certain extent, the lines of production.

Of a national area of 125 000 km², 76 000 km² are agricultural land; of these 4.7 million ha are arable, 2.8 million ha are grazing range and forest, and 0.6 million ha are fallow. This land is broken up into 326 500 farms, of which 274 000 (84 percent) are of less than 20 ha, 46 000 (14 percent) are of 20 to 100 ha, and 6 500 (2 percent) are of more than 100 ha.

These three subsectors each cover about one third of the country's agricultural land but differ widely in their receptivity to innovations. On small and medium-size farms development action comes up against a lack of resources, while on the very large farms it has to contend with a lack of motivation in landowners, who often do not live on their holdings. Thus the cooperative sector, established on 180 000 ha of erstwhile colonial estates, now supplies the bulk of the participants in the project.

The country's gross national product was about US$2 400 million in 1976 (at factor costs), of which only 16 percent ($392 million) was generated by agriculture. Livestock production, an important component of the agricultural sector, accounted for 28 percent ($106 million) of agriculture's share in the GNP. Within the livestock production sector, sheep made the largest contribution with $60 million, followed by cattle with $40 million.

A recent survey (Ministry of Agriculture, Bureau of Planning, 1976) estimated the number of cattle at 900 000 head, half of which were reportedly cows and heifers in calf. This is a low figure compared to the human population (6 million inhabitants), which yields a man/bovine ratio of 7:1, against 2 to 3:1 in many European countries.

The composition of the cattle population may be summarized as follows:

(*a*) a nucleus of 23 000 Friesian cows imported from the Netherlands or born of imported animals on state farms, a few cooperatives and a few private dairy farms;

(*b*) 150 000 head of "grade" cattle (obtained from crosses of European breeds such as the Austrian Brown Swiss and the French Tarentais) divided among most of the cooperatives and some of the private stock farms that have received government assistance; and

(*c*) the bulk (three fourths) of the national cattle population, owned by many small farmers with little land (in some cases, with none at all).

These local cattle have been tentatively classified as "Atlas Brown." More than half of them display several

Although the drain on funds available for development has today become a matter of prime concern, it should be emphasized that the effectiveness of a development operation is measured not by the millions of dollars that make its implementation possible but by the persistence of its effects, by the permanence of the technological innovations introduced, and by its real impact on production. While the project described in this article cannot be considered as one low financial input, its effectiveness does appear to be satisfactory according to these three criteria.

Before a closer look is taken at this project, it should be remembered that a development project exists not in a vacuum but in relation to the actual situation it is supposed to change: hence the following brief review of the crop and livestock situation in Tunisia.

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characteristics of successively imported breeds such as the Normandy, Eastern Red and White (Pie rouge de l'Est), Brown Swiss and Tarentais.

The small size and low productivity of the national herd are two major reasons why production has been unable to meet demand, necessitating large imports. Tunisia's annual milk production is estimated at 200 000 tons (Ministry of Agriculture, Livestock Subcommittee of the Fifth Plan, 1975), obliging the country to import the equivalent of approximately 150 000 tons of milk and milk products at a cost of about $16 million (National Institute of Statistics, 1975). With regard to meat, the situation is slightly better; with beef production at about 29 000 tons (carcass weight), imports are only some 5 000 tons, totalling about $10 million.

Characteristics of the project

The project, executed by FAO and the Tunisian Livestock and Pasture Office (OEP), has been operational since April 1974 and will continue until December 1978. The international budget of 1.6 million dollars is financed by the Swedish International Development Authority (SIDA). A distinctive feature is that almost half of this figure is for the purchase of equipment and supplies ($500 000) and the establishment of a revolving fund ($200 000). The national budget was initially set at $1.3 million, but subsequent allocations for financing operations under the project have raised this contribution to $3.2 million.

The staffing of the project consists of a central team of six FAO personnel and four Tunisian agricultural engineers based in Tunis. Eight assistant agricultural engineers are assigned to the OEP field offices in seven northern Tunisian governorates which contain 139 000 agricultural units covering an area of 28 000 km^2. These assistant engineers supervise some 20 technical assistants, each of whom is outposted to a cooperative farm from which he services varying numbers of participants.

The purpose of the project is to supervise the fattening of 6000, 12000, 18 000 and 24 000 bull calves during four successive years of operation.

Methodological approach

First of all, the technical team charted a development strategy to serve as a basis for its programme of work by bringing the objectives (mentioned below) into line with the characteristics of the production sector, while allowing for the natural technical constraints of the type of production concerned.

It quickly became apparent that for historical reasons common to all Maghreb countries livestock production, particularly cattle raising, plays a relatively modest role compared with cereal production, wherein lies the main part of the total feed potential. Thus 80 percent of the cattle population is kept on farms of less than 20 hectares occupying a third of the agricultural area; in other words, the stocking rate of beef animals is eight times higher in the subsector of farms of less than 20 hectares than in that of larger farms. In view of this, the project has tried to integrate the two subsectors by setting up an interchange system by which animals for fattening will be transferred from overstocked small farms to forage surplus farms, and by-products from major crops (e.g. sugarbeet pulp) will be made available to the small farms.

The choice of production system has also been an important consideration and had to take into account both natural (e.g. rainfall) and sectoral conditions (farm size). The traditional system of feeding hay was abandoned, mainly because of excessive losses in nutritive value. The economically more promising method of grazing is under study in a project supplementary to this, and has been encouraged in suitable regions.

Artificial drying of forage could not be considered because of the excessive energy cost. Zero grazing was practised to advantage on the small farms located in irrigation areas, but project focused mainly on introducing the ensiling technique on the major crop-growing farms. This kind of forage preservation appears to utilize the forage potential per unit area best and supplies the feed unit most economically. Moreover, this technique contributes to a lasting development of livestock production in the cereal production sector.

FIGURE 1. *A participant's barley/pea mixture is cut for ensiling, using one of the 54 choppers of the project.*

FIGURE 2. *Fattening in a conventional shed. Checking on feed consumption and growth performance is also done here.*

OPERATIONAL METHODS

The project's activities were undertaken according to two main lines of approach. The first of these was a vertical or inter-sectoral integration, coordinating all stages of the production cycle from the birth of the animal to its slaughter. In the pre-fattening stages the project created a completely new trade for store cattle which enables stock raisers to dispose of their production at the rewarding price of $1.20 per kg live weight. In the fattening stage the project deals simultaneously and in an integrated way with all the obstacles to the development of production, whether it be the production and preservation of forages, the financing of the operation, the production of concentrate feed, or the supervision of the fattening operation itself. In the post-fattening stages the project has established the Société Ellouhoum, which performs the functions of a meat marketing board in Tunisia, acting as the exclusive marketer of the production it supervises. It is with this semi-public body that the project arranges the programme of deliveries and sets the contract price ($2.30) per kg of carcass weight for the 1976-1977 production year). The second was by contrast a horizontal or inter-institutional integration, coordinating the project's activities with those of other related institutions. From this standpoint, rather than promote the creation of additional services resulting in dispersal and dissipation of effort, the project delegates the specific operations to existing bodies whenever possible. The project is thus involved in all the operations undertaken by OEP including its projects. A similar relationship also exists with the Office of Public Lands (OTD) which oversees the cooperative production farms connected with the project, the Central Farm Mechanization Cooperative (COCEMO) in the field of agricultural mechanization, the National Institute of Agricultural Research (INRAT) in the field of nutritional research, and the National Bank of Tunisia (BNT), to which the project will have to turn from 1977 onward to relieve its shortage of funds for operations.

Coordination between the central team and the field team is secured through weekly meetings of all the staff, frequent visits to participants, periodic refresher seminars, and a series of technical publications incorporating feedback from work in progress. In time technical authority, initially exercised by the central team, will gradually pass to the field team. Finally, it should be noted that the project and its participants are linked by a flexible but precise contractual arrangement that makes it possible at the same time to programme production in a reasonable manner, to avoid a paternalistic approach (in which assistance under the project would be seen as philanthropic aid not involving any specific commitment by the beneficiary), and to prefigure a responsible organization of the industry.

TECHNICAL ACCOMPLISHMENTS

The methodology adopted by the project confronts it with a host of problems in widely differing fields, such as business law and management (contracts), rural buildings (construction of silos and cattle sheds), agricultural and food industries (feed concentrates), the organization of transport (moving the animals from place to place), agricultural mechanization (assembly and maintenance of the project equipment), trade in cattle on the hoof (purchase of store cattle), the meat industry (characteristics of the carcasses produced), and animal production research (nutritional trials).

In addition, the project has to tackle the following specific problems in the field:

Control of fattening

During its second operational phase (autumn 1976-spring 1977) the project is supervising the fattening of about 10 000 bull calves, of which

8 000 were purchased with its own funds. These animals are distributed among 404 stockmen living throughout the project area. Of these stockmen, 152 are fattening their animals with grass silage in lots averaging 50 animals, while the remainder work with small-scale lots averaging three to four animals on a zero-grazing basis under the supervision of the Medjerda Valley Development Office (OMVVM) at Tebourba near Tunis, the Regional Agricultural Development Station (CRDA) at Ras Djebel near Bizerte and, in the case of the 40 participants at Menzel Bou Zelfa near Nabeul, under the direct supervision of the project.

Forage production and preservation

In the spring of 1976 the project directly supervised the harvesting of 3 375 ha of rainfed forage crops (mainly cereal-legume mixtures such as barley and peas and vetch and oats). For this operation 54 silage harvesters belonging to the project were used to fill 359 silos with a total silage volume of 72 000 m^3, equivalent to a feed value of some 7 500 tons of cereals.

Lotting and control of the stock

Between March and November 1976 about 8 000 bull calves passed through the centre located at Borj El Amri, 40 km from Tunis, of which 1 650 were imported on the hoof from Ireland and the rest purchased locally. The animals were divided into equal lots, tagged, weighed, given drugs and vaccinated before being delivered on project lorries to the participants. The distributed animals have been weighed periodically to check the rate of weight gain, the 13 000 weighings since June 1976 showing an average daily gain of 700 to 750 grammes.

Recording of costs

Systematic recording of the main production costs makes it possible to determine with adequate precision the net profit earned by each participant.

Veterinary control

The widely varying origins of the fattening animals and the epidemiological situation in the area of operations make veterinary supervision under the project an important factor in its success.

Results

The project has achieved considerable success in meeting its objectives, although its accomplishments thus far should in no way obscure what remains to be done. It should also be borne in mind that even in Europe it is rare to find groups of producers who have undertaken similar activities at such a sustained pace.

(*a*) *Assisting agricultural subsectors.* Among the 152 participants using silage as the basis for fattening, 118 are production cooperatives totalling 4 500 cooperators on 107 000 hectares. Consequently, the development of fattening in the major crop growing sector will strengthen the cooperative production sector.

(*b*) *Creating employment.* It is estimated that converting forage into meat on the farm instead of marketing it as hay, as in the past, has generated an additional labour demand of 25.8 man-days per ha of ensiled forage, thus creating 290 new jobs for the current season (excluding additional jobs created in feed manufacturing plants and abattoirs).

(*c*) *Training technical personnel.* Although the project's impact in this sphere is impossible to quantify, the priority given to the advanced training of field personnel and to the training of herdsmen, middle-level staff and extension workers indicates that this objective will be amply attained.

(*d*) *Developing livestock production.* With regard to extension in silage making, the project's side effect cannot be illustrated better than by the fact that it is difficult to dissuade participants from feeding silage to their dairy cows rather than to the fattening cattle for which it was intended.

FIGURE 3. *Feeding silage in the open. The feeding system is based on a minimum of feed in the fresh state.*

(*e*) *Establishing an agricultural equilibrium.* The project has so far cultivated only 3 700 hectares of the 100 000 ha available in the participating farms. The area under fodder crops outside the project (126 000 ha) is still so large that the project can hardly be said to have modified already the rotation systems by substituting forage crops for fallow. Whether this objective has been attained can only be determined in the medium and long term.

(*f*) *Reducing production costs.* In 1976 the production of 160 kg live weight cost $195 when fattening was done with silage, compared with $215 when done with hay costing $4.76 per ton.

(*g*) *Stabilizing the producer's income.* The regulating role of fattening on major crop-growing farms is well illustrated by the progress made by the project in the Kef and Siliana regions, where cereals yield a marginal and unpredictable return. These two governorates now comprise 30 percent of the project participants, compared with only 12 percent during the preceding production period.

(*h*) *Reducing the balance of payments deficit.* In 1976 the Société Ellouhoum is estimated to have imported 7 000 head of beef cattle, compared with 33 000 head purchased on the domestic market (4 300 of which were supplied by the project). It is estimated that 730 tons of meat (carcass weight) marketed by the project reduced the volume of imports and thus saved, at $2 000 per ton, $1.5 million in foreign exchange.

(*i*) *Improving the protein intake of the population.* The net national production attributable to the project will supply an additional 112 g/year of beef *per caput* at the end of the current production period. This figure is still modest when it is considered that between the 1968 and 1976 food consumption surveys *per caput* beef consumption was found to have increased from 3.5 kg to 6.5 kg/year.

- A number of problems must be faced if the momentum generated by the project is to be maintained. For instance, it will not be possible to supply the participants with a sufficient number of store cattle of satisfactory quality unless effective action is taken to improve cow-calf production itself. Such action should only be thought of in the context of a supplementary project or a specialized institution.
- Again, with regard to the fattening operation itself, the scarcity of qualified, permanent and adequately motivated personnel necessitates linking regular and advanced training to the system of remuneration.
- Even though a good number of the technological innovations of the project now appear to be fully accepted, its transformation into a permanent management agency, whether within or outside the OEP, entails the establishment of a structure that enjoys real managerial autonomy.
- The project is most vulnerable on its marketing side. National production will have to be protected from the competition of beef available at dumping prices on the international market by a rigorous programming of imports, or even by raising customs barriers.
- However, it is fair to say that the purely technical problems of beef production intensification have been solved. If therefore with the project's help adequate solutions can be found to the problems mentioned above, the latter part of the decade, coinciding with the end of the fifth Five-Year Plan (1976-81), could be a period of real livestock development in the technically most advanced subsector of agriculture, culminating in the self-sufficiency in beef.

FIGURE 4. *Lecture with slides in a participant's shed as part of the project's extension activities.*

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ultra-high-temperature treatment of milk and milk products

T.R. Ashton

Although it had been known and practised from time immemorial that the application of heat to foods was one of the many ways of preserving or extending its keeping quality, it was not until 1860 that Pasteur explained the technical or scientific reasons underlying the effect as it applied to milk. Stated simply, he found that if milk was boiled for several minutes, bacterial growth and eventual spoilage would still occur during subsequent storage under non-refrigerated conditions, whereas if it was subjected to a temperature of 110° to 112°C under a pressure of 1.5 atmospheres the growth of bacteria would be suppressed.

These facts — at that time (and since) most momentous and important — established the basic principles of the heat treatment necessary to extend milk's keeping quality beyond a few hours.

By the end of the 19th century this discovery had led to the commercial development, on a very restricted scale, of two processes of heat treatment, pasteurization, and sterilization. *Pasteurization* was the process in which milk was heated to approximately 60°C (140°F), held at that temperature for 20 to 30 minutes and afterwards cooled by gravity flow over a tubular cooler through which cold water circulated. Alternatively, the milk was "flash"-heated to a temperature of 76.6°C (170°F) and then cooled. When glass bottles became available in the early years of this century, pasteurized milk was sometimes bottled and sealed by means of a card-board disc.

During the first forty years or so of the 20th century, the sale of untreated milk gave way more and more to that of pasteurized milk. In part this was due to improvements in the fabrication of processing plant and equipment (stainless steel having replaced tinned copper), to improvements in instrumentation, and to the introduction of mechanical refrigeration for cooling and for cold storage. During this period, too, the unhygienic card-board disc gave way to the aluminium foil cap overlapping the rim of the bottle. From 1940 onward the High Temperature Short Time (HTST) method of heat treatment superseded the "Holder" method which had previously been an officially accepted system of pasteurization. At about the same time, improvements took place in bottle-washing equipment and in handling methods, enabling higher speeds of throughput to be obtained. *Sterilization* was a process in which pre-warmed milk was bottled, then heated in an autoclave to a temperature of 107.2° to 110°C (225° to 230°F) and held at that temperature for 20 to 30 minutes. After this the pressure in the vessel was allowed to fall until the temperature was below boiling point, when the bottled milk was removed with minimum disturbance and sealed by means of a rubber-washered "swing" stopper permanently affixed to the neck of the bottle.

Improvements in processing followed rapidly between 1900 and 1925, among them the development of the homogenizer which obviated the troublesome cream plug formed during the static heating phase by aggregation of the fat, which was not dispersed during cooling, and the replacement of the "swing" stopper by the "crown cork" seal, which allowed the bottle to "breathe" during heating and became a vacuum seal during the cooling cycle. All this led to increasing sales, especially in the more industrialized areas where a long-keeping milk was required. Sterilized milk soon became identified by its caramelized flavour, which to many became a mark of acceptability more desirable than the less distinctive flavour of pasteurized milk, which was also available.

By the early 1930s sterilized milk was also being produced by a continuous method. This system consisted of preheating, homogenizing and filling the hot milk into bottles,

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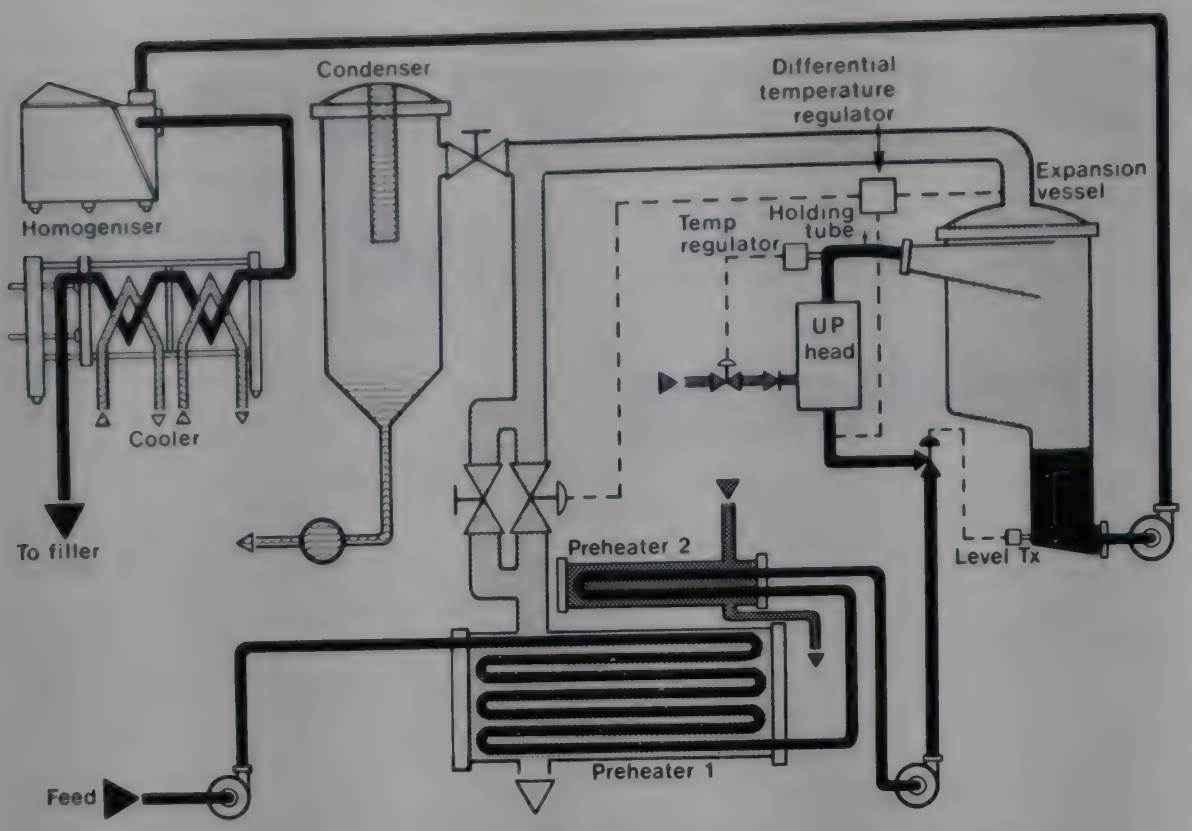


FIGURE 1. *Flow diagram, UHT direct injection plant (Uperiser).*

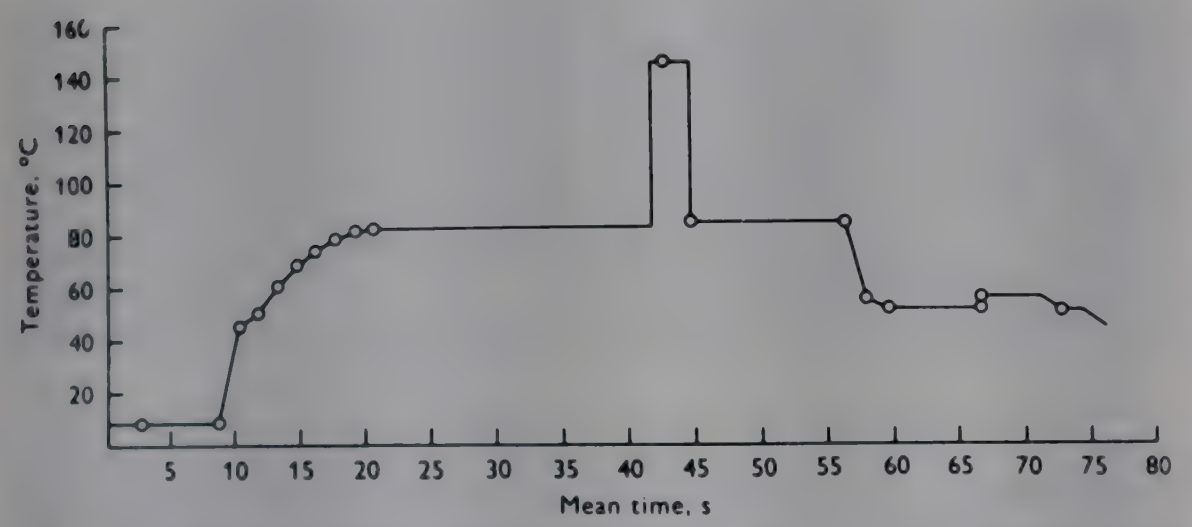


FIGURE 2. *Temperature/time heating and cooling curve for UHT injection plant (Uperiser).*

sealing them with crown corks and then feeding them automatically into bottle carriers which passed through three chambers in succession: first, a hot water chamber which served as a barometric leg to a steam chamber maintained at a temperature between 107.2° and 110°C (225° and 230°F), followed by a counter-pressure cool water chamber, from which the bottles were discharged for crating. The time of traverse through the steam chamber was generally 30 minutes in the early machines, but this was reduced to 20 minutes when higher temperatures of 110° to 115.5°C (230° to 240°F) came to be adopted.

Neither of these sterilization methods gave milk that could always be guaranteed to have long-keeping properties — in fact, souring could and often did occur within one or two weeks, especially in warmer weather. Whether on a limited or extensive scale, this shortcoming proved to be due to the thermal tolerance of certain bacterial spores, naturally habitant to milk, which were resistant to the time/temperature conditions of treatment.

The need for a more severe treatment to destroy these naturally occurring spores effectively was met by substituting a very high temperature/short-time treatment (about 132.2°C [270°F] for two to three seconds) for the low preheating stage, formerly carried out at about 60° to 71.1°C (140° to 160°F). This modification to the system gave fewer failures but did not entirely eliminate them, because although the new pre-treatment was probably adequate to kill the spores present in the milk, the in-bottle sterilization process which followed was not sufficiently intensive, in terms of time/temperature effect, to kill any spores remaining as contaminants on the internal surfaces of the glass bottles after washing, nor those adventitious spores which had gained access to the milk during filling and capping.

By 1950 it became quite clear that to be fully effective, a high-heat treatment of the milk must be combined with aseptic filling and sealing as a continuous three-stage system, during which it would be impossible for the milk to be contaminated by any means.

The first commercially viable Very High Temperature Short Time (UHT) milk processing plant — the Uperiser — developed in Switzerland by Alpura Ltd., Berne, and Sulzer Bros. Ltd., Winterthur, in collaboration with Bernese Alps Ltd., Konolfingen, and linked to a Martin-Aseptic canning plant made by James Dole Engineering Co., San Francisco, California, came into operation in 1953. This system, with modifications, remains one of the most advanced of any in use today.

Ultra-high-temperature treatment systems

HEAT TREATMENT

The available types of heat treatment plants show considerable differences in design features: in heating and cooling methods, instrumentation, etc. Plants can be divided into two main categories according to the manner of carrying out the final heating stage:

(*a*) the *indirect* system, which depends on heat transfer from heating medium to milk (or product) through a separating barrier;

(*b*) the *direct* system, in which heat exchange is effected by the admixture of steam and milk (or product).

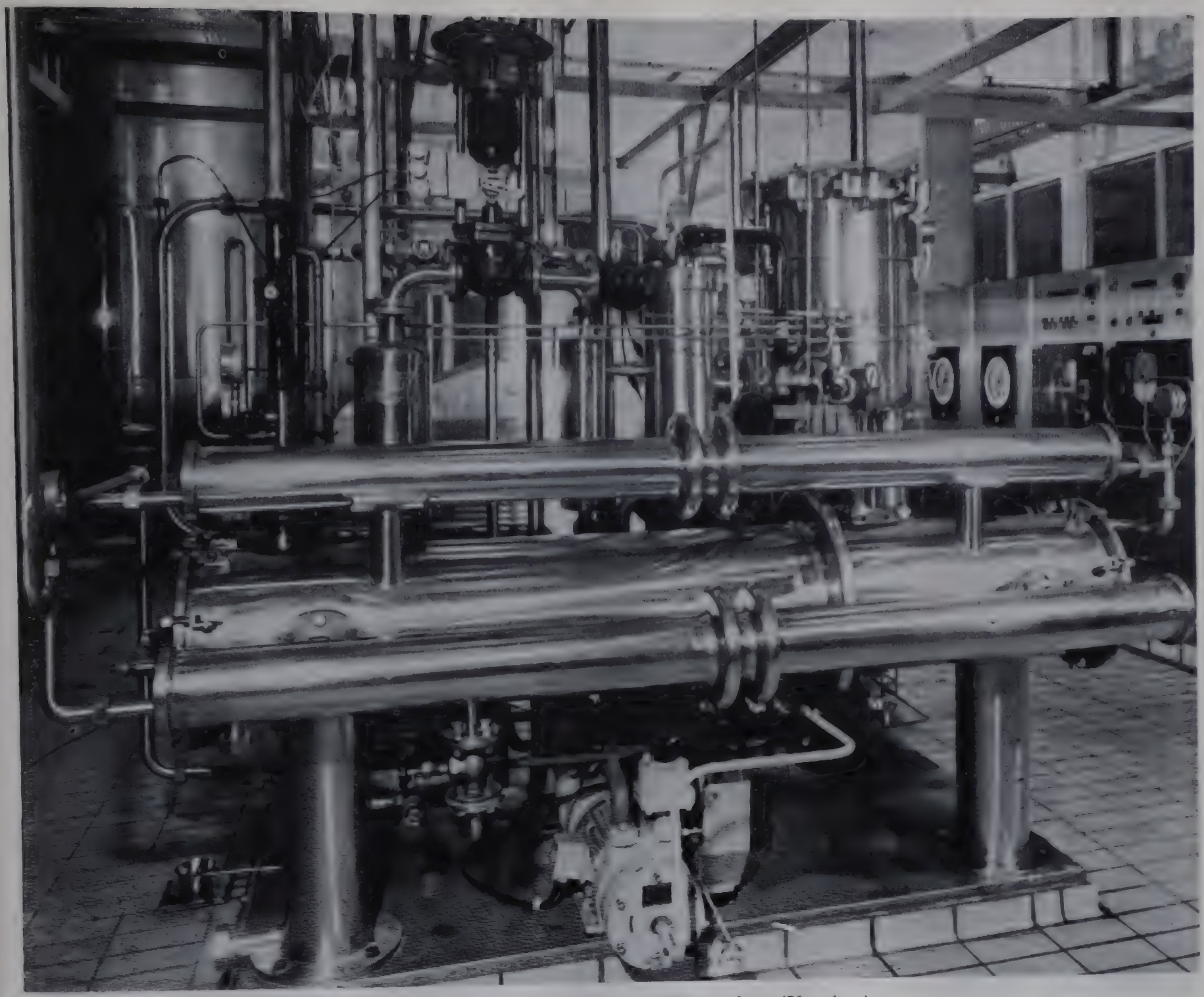


FIGURE 3. *Typical UHT direct injection plant (Uperiser).*

A more detailed subdivision of plant conformation within these two categories is as follows:

The indirect system includes heat exchangers of three types: tubular, plate and scraped surface.

The direct system includes plants based on injection (in which steam under pressure is injected into the milk) or on infusion (in which milk under pressure is sprayed into a steam chamber maintained at high temperature).

On attaining a temperature usually within the range of 140° to 150°C (284° to 302°F) with a nominal flow holding time of 2 to 3 seconds, the milk is cooled, the methods of cooling in different plants also differing considerably. In direct heating plants, the milk is usually "flash"-cooled as a first stage by injection into a vacuum chamber, the vacuum being adjusted to allow for the removal of an amount of water vapour equivalent to that added during the heating phase. The second stage, in which the milk is cooled to filling temperature, is usually carried out by heat exchange, using the regenerative principle or cold water as coolant.[1]

Figures 1, 2 and 3 and Figures 4, 5 and 6 illustrate the flow patterns, the appearance, and typical temperature/time heating and cooling curves for processing plants of the direct heating type and the indirect heating type respectively.

[1] The regenerative principle of heating/cooling is the exchange of heat between the incoming cold or cool milk and the heated milk from the final heating section in indirect plants or after the "flash"-cooling stage in direct plants

ASEPTIC FILLING AND SEALING

When the first truly commercial aseptic filling and sealing system was installed at Konolfingen, Switzerland, the containers used were made of aluminium.

Essentially, the Martin aseptic filling method consisted of a long, totally enclosed, tunnel in which the aluminium cans were heated to about 250°C by superheated steam, cooled

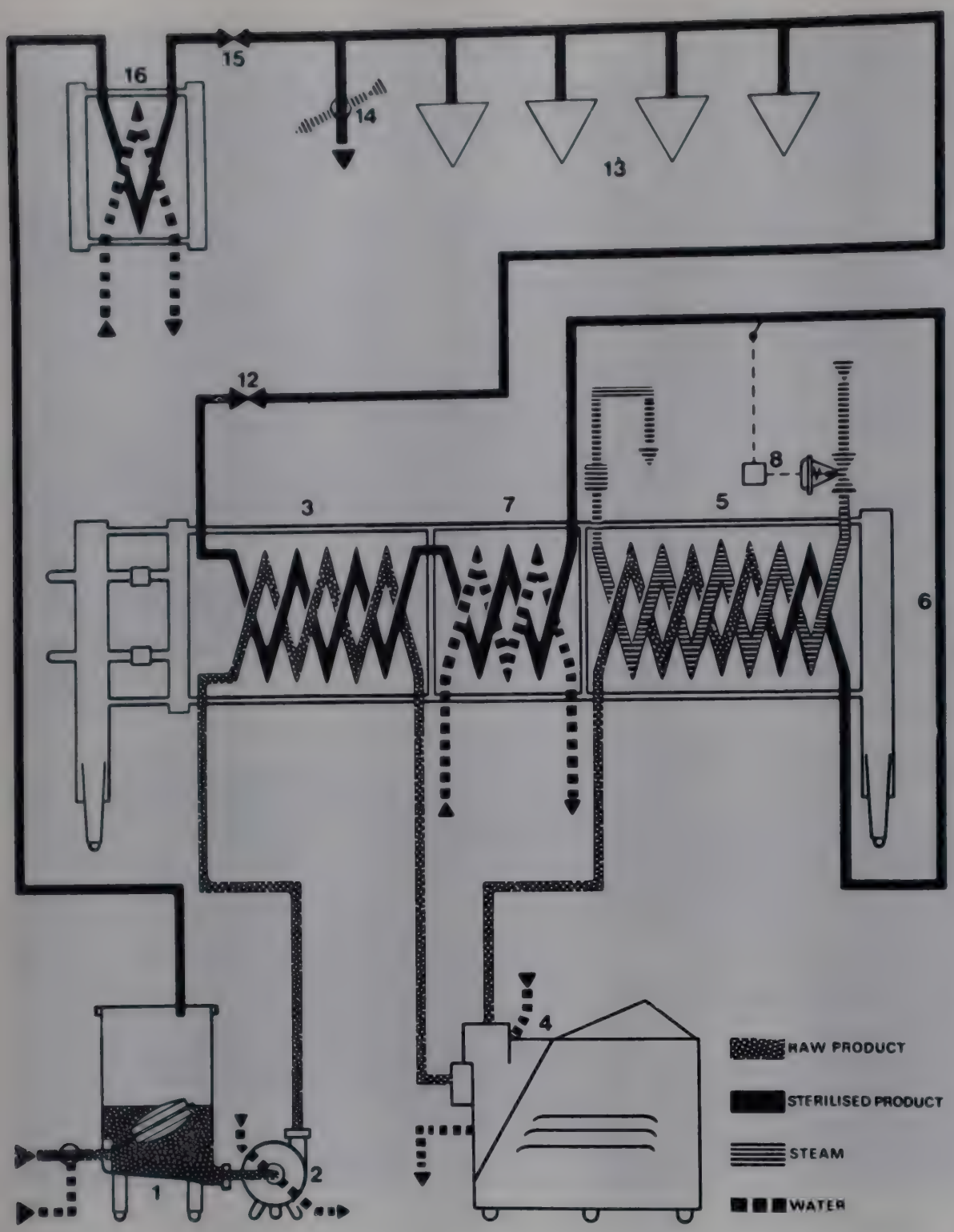
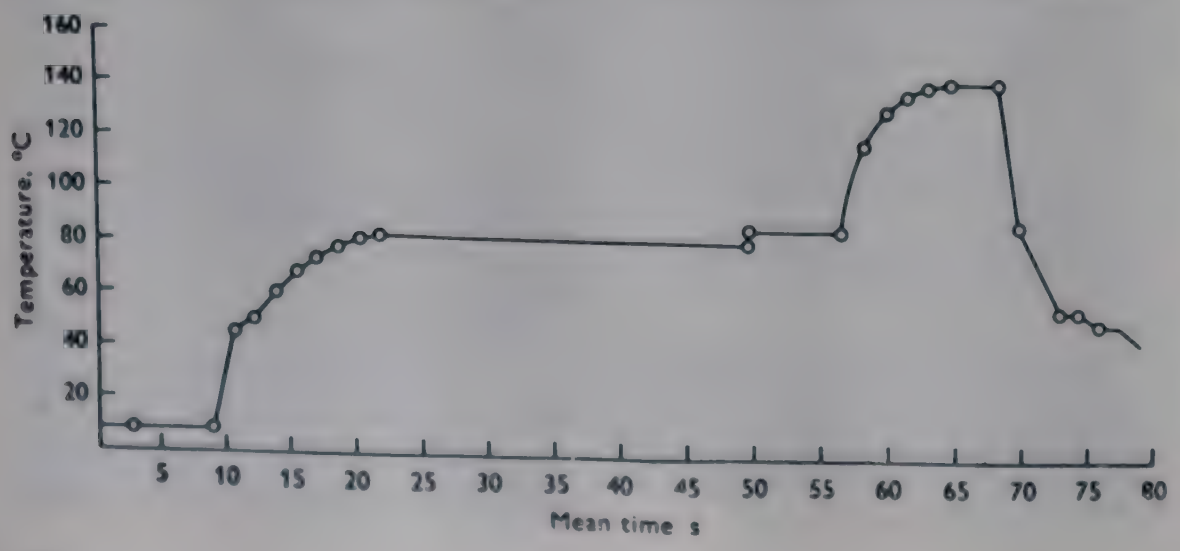


FIGURE 4. *Flow diagram, UHT indirect heating plant system.*

FIGURE 5. *Temperature/time heating and cooling curve for indirect heating plant.*



by the steam condensate, filled and finally sealed, the whole sequence being carried out under aseptic conditions. Because the process itself was expensive in terms of capital and running costs, but more especially because of the high cost of the containers, the system, though effective, remained the only one of its kind for some time. Nevertheless, it evoked much interest. It was only after the aseptic Tetra-Pak machine was introduced by A.B. Tetra Pak of Lund, Sweden, that UHT milk, aseptically packaged, was seen to have a much wider potential, because of the much lower container and packaging costs as compared with the can.

Since about 1970 other types of containers and other aseptic filling and systems have been introduced, with interest in UHT milk and products continuing to grow from year to year.

The range of materials and types of containers now used includes glass (bottles and jars), metal (cans and drums), laminates of paperboard, plastics or aluminium foil (cartons and sachets), and flexible, semi-rigid or rigid plastics (sachets, pouches, bag-in-box containers, and moulded bottles, cups and pots). The shapes of containers vary considerably — laminated cartons may be tetrahedral or brick-shaped, with flat or gable tops; some plastic sachets are free-standing on an oval or square gusset-type base; rigid or semi-rigid plastic bottles may have fitted/moulded handles. In capacity, containers cover a wide range, from single-portion cartons or pots of approximately 14 cc (½ fl oz) to bulk drums of about 225 l (approximately 50 gal).

The production of UHT milk and products in cartons, pouches or sachets, and in pressure-formed high-density polyethylene or polypropylene containers, follows the principles of the continuous form-fill-seal aseptic system originally developed by A.B. Tetra Pak for their tetrahedral carton.

The following is a brief description of a Tetra Pak aseptic installation (see Figure 7), indicating the sequence of stages from reel of laminate to filled and sealed cartons ready for automatic crating or for collation prior to overall wrapping:

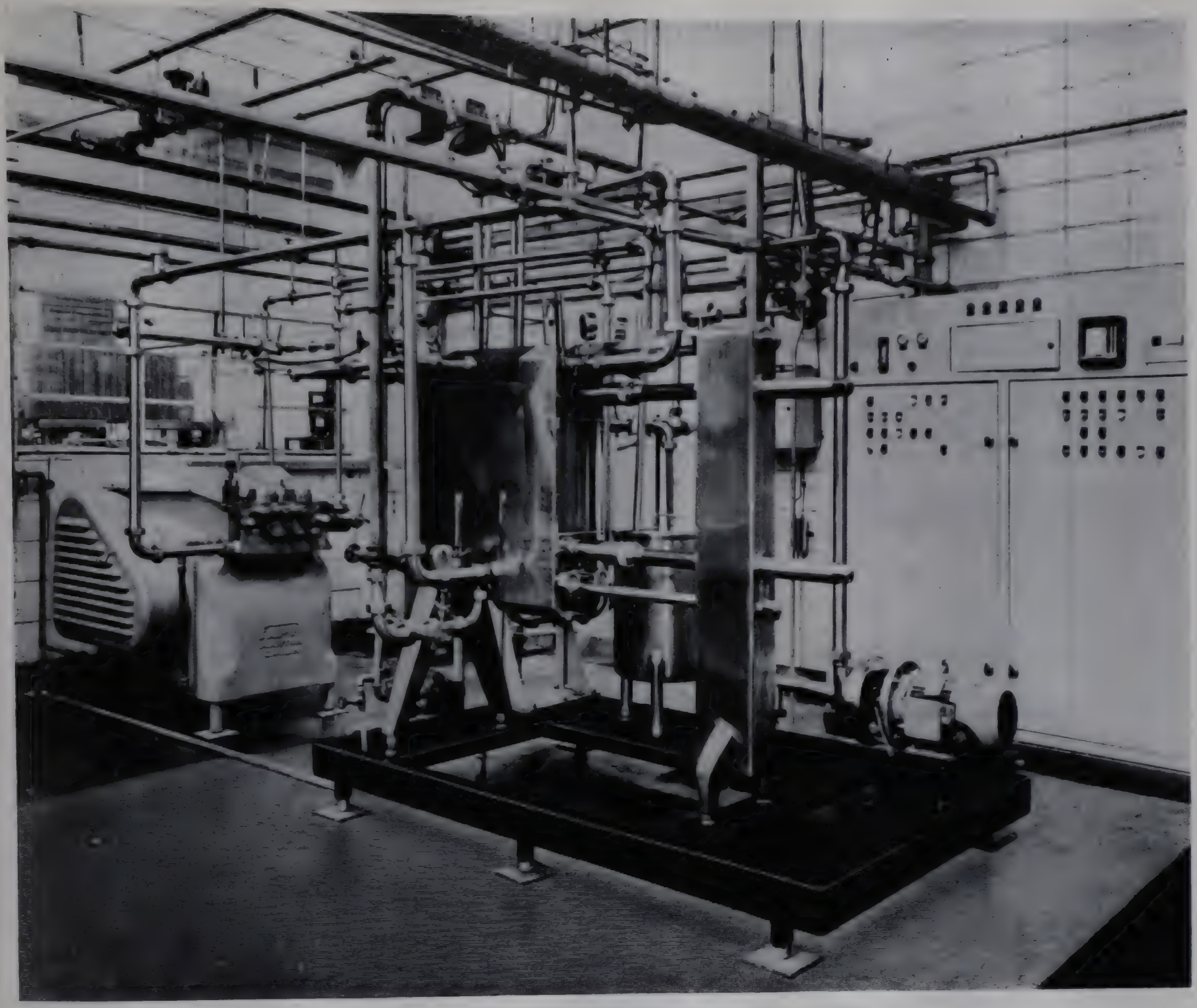


FIGURE 6. *Typical UHT indirect heating plant (APV).*

From the reel, the laminate (1) — usually polyethylene/kraft composite paper (external face white, internal face brown)/polyethylene/aluminium foil/polyethylene lined — first passes through a bath (2) containing a 17% H_2O_2 solution with a small amount of wetting agent, to be formed into a tubular shape which is then side-seamed by heat to form a continuous tube (3). As the tube moves downward, any sterilant residue is evaporated to atmosphere by a radiant heater (4) surrounding the filling pipe (6). Following transverse sealing (7) at a point below the mouth of the filling pipe, the carton is filled and then top-sealed by a second set of heated jaws set at right angles to those which formed the bottom seal. On further downward traverse, the cartons are detached from one another by cutting jaws (8) before they pass to the automatic crater or collator. The whole operation is carried out in an aseptic atmosphere (5).

Practical and economic aspects

(*a*) Whole milk, standardized milk, recombined milks, etc., can be subjected to UHT treatment to give satisfactory end products.
(*b*) In general, the capital and running costs of the direct system are higher than those of the indirect heating system.
(*c*) For the treatment of products of a viscous consistency, or those which become viscous during the heating or cooling phase, scraped-surface heat exchangers linked to pressure fillers of the straight-through type are often the only system which can be used.

ORGANOLEPTIC PROPERTIES

(*a*) UHT milk produced by either the direct or indirect heating systems has a perceptible "cooked" flavour when freshly processed, the intensity of which diminishes with time.
(*b*) For an acceptable flavour over

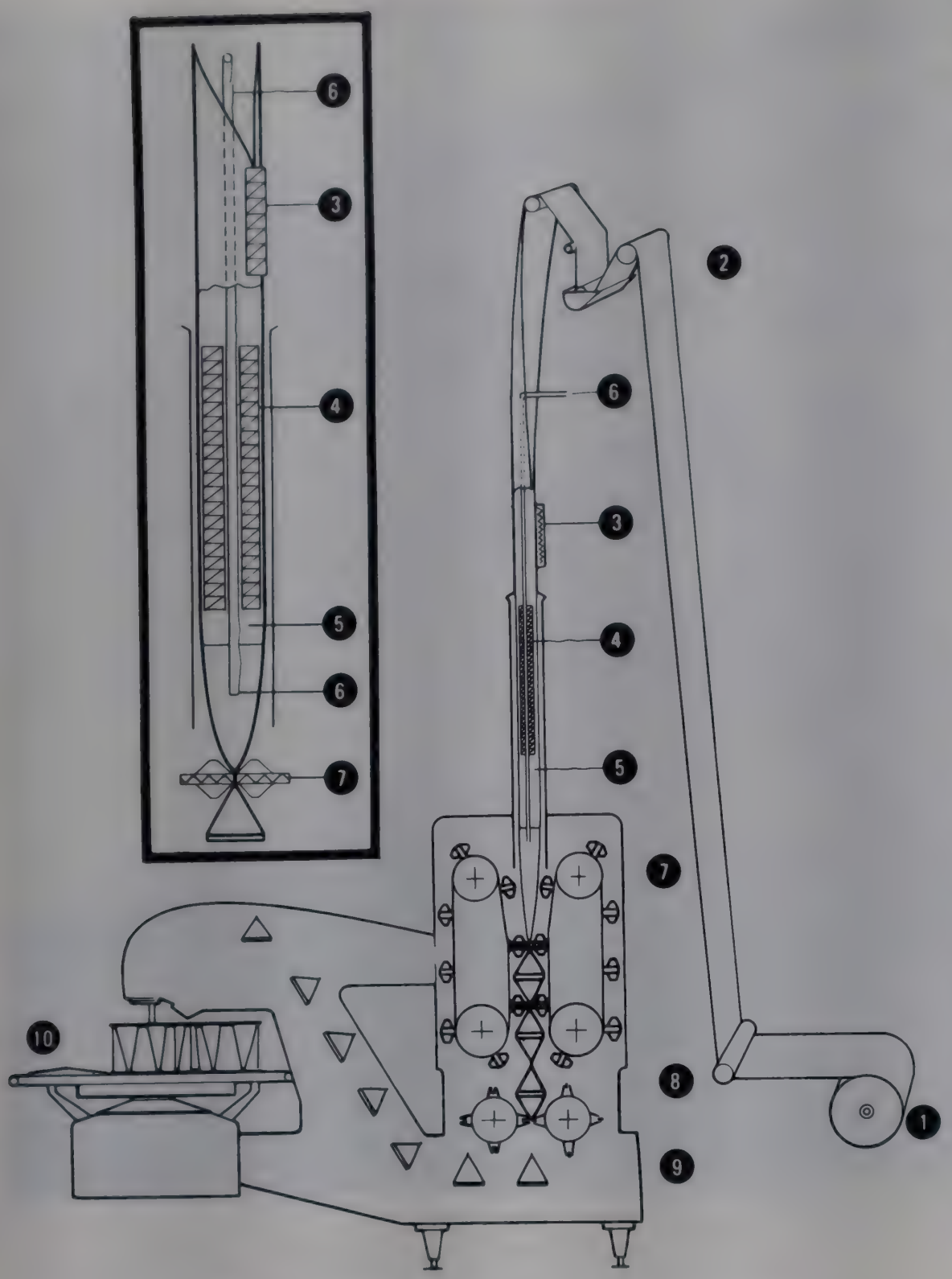


FIGURE 7. *Diagram of Tetra-Pak aseptic filling system.*

a long period of time, containers used for UHT milk must not transmit light nor must they be permeable to oxygen or other gases. Lack of protection against gas absorption (oxygen) and light causes a rapid deterioration in flavour, the rate of change being a function of temperature and storage time.

(*c*) In non-permeable containers, UHT milk reaches an optimum flavour during the period between the fifth and twelfth days, after which it begins to deteriorate. The currently accepted views are that UHT milk has a distinctive but not unpleasant taste for the first month after processing, that it remains palatable for a period up to three months, but that acceptance beyond this time depends on individual taste sensitivity, and especially on whether the consumer is accustomed to the flavour of freshly pasteurized milk.

NUTRITIONAL ASPECTS

(*a*) From the nutritive point of view, freshly-processed UHT milk is little different in vitamin content from pasteurized milk. With respect to the thiamine, vitamin C, folic acid and vitamin B_{12} contents, the process of sterilization causes greater losses.

(*b*) Irrespective of the post-processing oxygen content, and incidentally of the heating system used, the vitamin C and vitamin B_{12} contents decrease to the 40% and 60% levels respectively in 60 days. Losses of ascorbic acid and folic acid as shown by experimental evidence, are however related to the initial oxygen content level:

	Initial oxygen content (ppm)	
	0.1	8.0
Ascorbic acid	20%	100%
Folic acid	0	100%

(*c*) It would appear that oxygen content and changes in organoleptic properties of UHT milk are also associated with the different systems of heat treatment, with the heating and the cooling methods considered separately and together. De-aeration of the milk, if carried out, and other factors must also be taken into account. Others may, however, disagree with these views.

Further reading

Readers requiring more detailed information on the subject of UHT treatment may refer to the following publications:

IDF (1972) Annual Bulletin, Part V, IDF Monograph on UHT Milk.

Ultra-High-Temperature Processing of Dairy Products. Proceedings of a Seminar organized by The Agricultural Institute, Republic of Ireland, 21-22 May 1969. Society of Dairy Technology, 17 Devonshire Street, London, WIN2BQ.

The author is grateful for the assistance he has been given by Mr. C.H. Brissenden of the A.P.V. Co. Ltd., Crawley, England, and by Dr. H. Burton of the National Institute of Dairying, Shinfield, Reading, England, for supplying him with photographs and diagrams to illustrate this article. He is also very appreciative of the help he has been given by his former secretary, Miss Margaret Hewett, N.D.D., in editing the script and preparing it in suitable form for publication.

Current situation and outlook for animal feeds and animal products*

CEREALS

The outlook for 1977 world coarse grain crops is favourable, and, barring exceptionally bad weather in the coming months, another large harvest is anticipated.

Based on current conditions of winter sown crops and spring plantings already made and planned, FAO forecasts coarse grain production in 1977 to reach 718 million tons, some 3 million tons above 1976 and a new record. The forecast is of course very tentative since most crops are just being planted in the Northern Hemisphere and are thus heavily dependent on weather conditions in the growing season.

The outlook for United States coarse grains has brightened. On present indications, FAO forecasts a coarse grain crop for the United States of 190 million tons, only slightly below last year's record of 193 million tons. In Latin America a large maize crop and a record sorghum crop are being harvested in Argentina; in Brazil a large maize crop is expected in spite of rains which have caused some damage. The South African 1977 maize crop is now estimated at 9.5 million tons, compared with only 7.3 million tons in 1976; a large sorghum crop is also expected. A significant recovery is forecast for coarse grains production in Europe this year from the low 1976 level. In the U.S.S.R. the weather has been favourable for sowing spring grain.

The use of wheat and coarse grains as animal feed increased considerably as compared with 1975/76. The main reasons were: the recovery in grain feeding in the U.S.S.R. made possible by a record harvest; the improved livestock/feed price ratio which led to further increases in grain feeding in developed countries; and the drought in Europe which led to some recourse to cereals as feed, both domestically produced and imported. Although livestock numbers may not expand in 1977/78, some increase in grain feeding is likely due to an expected improvement in livestock/feed price ratios. A further increase in demand for grain as animal feed is also expected in eastern Europe and the U.S.S.R. where demand for livestock products (and thus also for grains as feed) continues to grow.

For trade in coarse grains some expansion is expected in Japanese imports and in the requirements of the Near East and Latin America. However, it is unlikely that these changes will offset lower imports expected in western Europe, where trade in 1976/77 was at record levels. The U.S.S.R. and eastern European requirements could be lower. Stocks in major exporting countries are expected to increase unless present production prospects deteriorate markedly.

International market prices of coarse grains have fallen in the last months, reflecting the improvement in growing conditions in the United States. The price falls might have been even sharper in the absence of the large increase in soybean and soybean products prices, which gave some support to the cereal complex.

OILSEEDS, CAKES AND MEALS

Under the lead of soybean and soybean products, international prices of most oilseeds and products have continued to show an upward trend throughout most of April. Since late April, however, this upward trend in European import prices appears to have been arrested, with some marked temporary fluctuations reflecting general short-term uncertainties. Compared with a year ago, prices of selected major oilseeds and meals were in April 1977 around 80 to 90 percent higher. The growing strength of prices on world markets so far this year has reflected an increasingly tight supply/demand position. In recent weeks a number of new price-supporting factors have given additional impetus to the overall price rise. The prospects of a large increase in the soybean crop now being harvested in Brazil have further deteriorated, reflecting an expected reduction in yields following excessively dry weather, particularly in Paraná; the reduced estimate currently used of a crop of some 12.0 million tons, representing an increase of some 0.8 million tons over the estimate for 1976, may well prove eventually to be on the optimistic side.

With regard to fishmeal, the initial anchovy fishing campaign in Peru was suspended unexpectedly early in May, so that 1977 total fishmeal production in the country is now likely to be lower than in the preceding year. However, world demand for oilseeds and protein meals has continued strong, particularly for soybean and products. In western Europe, unusually cool weather conditions are reported to have resulted in more meal usage than would normally have been expected. Looking ahead in 1977/78, there appear to be good prospects that, with the current favourable price levels, output of oilmeal protein will increase distinctly above the reduced levels of this year. World supplies will, however, not increase commensurately, as beginning stocks will be sharply reduced from their high levels of a year ago, particularly as regards U.S. soybeans. It is now expected that U.S. farmers will plant more soybeans than earlier intended, mainly as a result of the soybean/corn price ratio having risen to four to one since 1 April; weather conditions have been so far favourable in the main U.S. growing areas, so that a crop of over 44 million tons (or 10 million tons more than a year earlier) could be achieved if favourable weather continues. U.S. cotton growers are now intending to increase area by 17 percent, and a very sharp increase is also

* As of May, 1977.

expected in plantings of sunflowerseed and linseed. The expected continuing favourable world price levels in coming months should act as an incentive to soybean farmers in Brazil to expand once again their plantings. The current planting intentions in Canada report a very sharp recovery in rapeseed plantings and larger areas under linseed and soybean.

It thus appears that in 1978 world output of oilmeal proteins will be higher than in 1977, although it is too early to attempt a quantitative assessment of this increase. As for output, an unusually large increase would be clearly required — particularly of those oilseed crops with a higher protein content — to reach again the projected long-term level for 1978 after the reduced production of 1977. Furthermore, there is a need for some replenishment of stocks, which would enhance supply security and bring about a better balance between available supply and demand, the latter being likely to continue strong next season.

☐ MILK AND MILK PRODUCTS

World milk production has grown only slowly so far in 1977, largely because of the tight winter fodder supply situation in Europe and North America, which was aggravated by rapidly rising prices of protein feeds. However, in the world's largest producing country, the U.S.S.R., milk output continued its recovery after the 1975/76 setback. Butter production in the U.S.S.R. during the first four months of 1977 was 23 percent higher than last year. Nonetheless, since 1973 the U.S.S.R. has again emerged as a large-scale buyer on the international butter market. In recent weeks, approximately 50 000 tons were purchased mainly in the EEC and New Zealand. The U.S.S.R. imports, which followed the further reduction of EEC export prices, are being made in order to add to the short supply of other food fats and to rebuild stocks which had fallen to very low levels during 1975-76. The EEC also sold larger quantities to eastern European countries, where milk production continued to suffer from the effects of last year's drought while demand increased. In addition, the petroleum exporting countries remained active buyers.

The sizeable exports have limited the increase in EEC butter stocks this spring. Skim milk powder stocks actually fell further until recently in the EEC, as well as in Canada and Oceania, reflecting reduced production and extensive surplus disposal measures on domestic markets and abroad. Present stocks of milk products in western Europe, however, are still well above normal trade requirements, and in the United States stocks have shown a marked increase this year. During the next few months, the upward trend in stocks will be resumed in western Europe and continued in North America. With the beginning of the grazing season, dairy farmers' dependence on concentrate feeds has now decreased, and, assuming normal weather, the growth of milk production in the northern hemisphere should accelerate over the next half year or so.

Demand prospects remain unfavourable in most developed countries, notably for butter. In centrally planned countries, provided that the weather is normal, the recovery of milk output should gain momentum in 1977/78, and their imports should fall. By contrast, import demand of developing countries, notwithstanding greater efforts to raise local production, can be expected to grow further. Yet commercial outlets in developing regions, as well as in Japan — the only major developed deficit country — will not be large enough to absorb the surpluses produced by developed countries. Hence, it is still essential to adjust milk production in western Europe, North America and Australasia.

Australia and Canada will probably continue their policy of curbing milk output, and some west European countries have recently taken or are at present actively considering steps in this direction. The EEC Council of Ministers has agreed to a programme reducing dairy cow numbers. The EEC and other countries have also raised 1977/78 prices to milk producers less than in previous years and, indeed, often by less than the inflation rate. This will not only benefit demand but should also have some effect on production, all the more so as concentrate feed prices could remain relatively high. In the EEC, however, where in recent years milk products equivalent to about a quarter of milk production were disposed of at heavily subsidized prices, the recently decided measures will not be sufficient to adjust output to commercial outlets in the near future. Only by continuation of current action to dispose of skim powder at low prices on domestic markets and abroad and by intensification of the measures to encourage butter consumption will it be possible to prevent stocks from growing again.

In the United States — the only major surplus producer where the rise in milk support prices has again been rather sharp this year — there may be a marked expansion of support purchases of butter and skim milk powder. Especially in the EEC and the United States, surplus disposal action will continue to include large-scale supply of milk products for food aid. In commercial international trade prices are likely to remain depressed.

☐ MEAT

Forecasts for the major producing countries indicate that, after three years of relatively rapid growth, world production of the four major types of meat combined will increase by only a little in 1977.

The cyclical decline in beef production in western Europe and North America is expected to last through 1977 and into 1978. The combined beef and veal output of these main importing areas will be about 5 percent (or close to one million tons) short of the 1976 volume. Beef and veal production is not expected to change significantly in eastern Europe and the U.S.S.R. Among exporters, there will be a marked reduction in cattle slaughterings in Oceania, mainly on account of Australia — the first of such reductions in the past ten years. Beef production, however, might not be affected to the same extent, as recent reports indicate that favourable pasture conditions might allow animals to be slaughtered at higher weights. Further, substantial increases are forecast in beef production in the Latin American exporting countries with the exception of Argentina, where there will be a significant decline following the reduction of cattle inventories in 1976.

World production of mutton and lamb is likely to be lower in 1977. Drought losses in Australia and higher ewe retention rates in the major producing countries will result in less mutton, but increased lamb production will be an offsetting factor, reflecting good market prices as well as to some extent the larger breeding herds.

Pigmeat production will show marked cyclical rises in western Europe and North America, and this will largely counterbalance the decline in beef production. Pig numbers were below corresponding 1976 levels in eastern European countries at the beginning of 1977, and this is likely to cause pigmeat production to remain below the previous

year's levels for most of 1977. The recovery in pig numbers is probably the basis for the optimistic outlook for total meat production in the U.S.S.R., where production targets are set for an increase of nearly 10 percent during 1977.

The outlook for poultry meat production in western Europe and North America is for further but more moderate increases than those obtained in 1976. On the other hand, the eastern European countries and the U.S.S.R. are expected to try to maintain last year's high growth rates, especially in view of the continuing tight supply situation for red meats.

Provisional estimates of meat trade in 1976 show an increase of nearly 10 percent in world exports of fresh, chilled and frozen meats; prepared and canned meat exports also rose by some 5 percent. Another major expansion is not expected for 1977, especially for beef trade, which accounted for most of the increase in 1976. Demand for meat is recovering slowly in the major consuming countries, while their domestic meat supplies will apparently be ample in spite of the fall in beef production. Heavy EEC stocks will limit beef imports and also add to supplies available for the world market. Until these stocks are worked down, there is little likelihood of large increases in imports by the Community; in any case, the changes in the Community's import regulations since April would not necessarily facilitate such an increase.

A small reduction is now forecast in U.S. imports of beef. Voluntary restraint arrangements with traditional suppliers will limit those imports of meat subject to the U.S. import law (primarily frozen beef) to 515 000 tons, product weight, compared with actual 1976 imports of these meats of 559 000 tons. There have been substantial beef purchases by eastern European countries and the U.S.S.R. so far this year, and these countries, together with markets in the Near East and Africa, will probably account for most of any increase in world beef trade in 1977. As for exporting countries, decline in their beef production will contribute to a rise in domestic prices and thus to a reduction in consumption, so that export availabilities are likely to remain high. Trade in pigmeat will be influenced by high production in western Europe and North America. Import demand for mutton and lamb is likely to have no serious difficulties in absorbing the 1977 supplies of the main exporting countries.

International meat prices, with the exception of mutton and lamb prices, will be under downward pressure in the coming months. An improvement is expected, however, for beef during the second half of the year, when EEC stocks might be worked down and supplies in the main exporting countries might become tight.

FAO/ECE Agriculture Division symposium

The symposium, Recent Developments in the Use of New Sources of Protein, Essential Amino Acids and Non-protein Nitrogen with Special Reference to Ruminants, organized jointly by FAO and the Economic Commission for Europe's Committee on Agricultural Problems, was held in Geneva from 10 to 14 January 1977. The meeting was attended by 55 representatives of governments, research institutes and industry from 17 eastern and western European countries. The International Atomic Energy Agency was also represented.

Fourteen papers were presented during four sessions, of which two dealt with dairy cattle and two with beef cattle. For both these animal groups one session was devoted to protein requirements, essential amino acids, non-protein nitrogen (NPN) and new sources of these nutrients; the second session was devoted to economic and other considerations for incorporating additional and new sources of protein and NPN into diets.

The Symposium summarized the standards being used in several countries for calculation of nitrogen requirements, and experience in using a number of new nitrogen sources, particularly in the form of NPN.

The most important points made were:

— In dairy cattle rations there is generally room for substituting true protein with NPN. However, the special problems of supplying high-yielding dairy cows with optimum protein and energy in the first one or two months of lactation appears to leave little opportunity for the effective utilization of added NPN. The use of "protected" proteins to cover the requirements of high-yielding cows could play an important role, and the necessary technological processes should be developed.

— Recent research of beef cattle nutrition indicates that protein requirements are lower than previously assumed provided that appropriate energy sources are fed. Regarding the use of NPN, there is generally more scope in rations for beef cattle than for dairy cattle. The potential of a number of new NPN sources was discussed.

— From the more general discussion it was concluded that (*a*) a direct relationship exists between protein requirements and energy input; (*b*) nitrogen requirements for the host animal and for the rumen microorganisms should be considered separately; (*c*) the large amount of new information about nitrogen metabolism in ruminants should be used for revision of protein requirement standards. Adoption of the new approach discussed will provide a means for predicting the likely response of cattle to nitrogen input in the various forms as related to energy input. Thus a basis could be provided for calculating the economic optimum at any time.

The delegates agreed to discuss observations on the practical use of new sources of protein in relation to energy supply for increased production of milk and meat at the next symposium.

The Secretariat was requested to seek a way of publishing the proceedings of the Symposium.

International Food Policy Research Institute

The Ford and Rockefeller Foundations have joined with the International Development Research Centre of Canada to support the establishment of an International Food Policy Research Institute. Located in Washington, D.C., the new Institute will have a staff of a dozen scientists drawn from both developed and developing countries and an initial budget of $1 million/biennium.

Its mission is to provide information and analyses concerning the world food situation and to conduct research on international policy aspects of food production, distribution, and trade. It will cooperate with FAO and other international groups in identifying gaps and opportunities for expanding world food production, and is expected to recommend actions that governments and international organizations might take to improve production, trade, and distribution of foods.

First Expert Consultation on breed evaluation and crossbreeding: the use of local Mediterranean cattle and sheep breeds in crossbreeding for meat production

In a recent article in *World Animal Review* (No. 21, p. 42), J.J. Lauvergne documented the rapid disappearance of native European cattle breeds by the spread of a few improved dairy and dual-purpose breeds. This process has gone farthest in northern and central Europe; in southern Europe many local breeds still remain. The work on the Aubrac (A) and Gascon (B) breeds in southern France and the Sardinian (C) breed in Italy has shown that such local adapted breeds still have a role to play in beef production. Under extensive management conditions the cows of the native breeds exhibit their adaptation to local conditions by a good reproductive performance and longevity. They can be crossed with improved beef breeds to produce a first cross animal which benefits from their maternal performance and from hybrid vigour and can be profitably used for breeding, or fattened for beef under improved conditions.

A consultation was held in Rome on 30 April and 1 May 1977 to hear more about these experiments and to discuss to what extent they were applicable in other Mediterranean countries. Thirteen individual experts came from eight countries, namely Algeria, France, Greece, Italy, Portugal, Spain, Tunisia and Turkey; there was also an observer from the EEC Commission. After four general papers which set the scene by describing the Mediterranean environment and the cattle and sheep breeds which had been shaped by it, each participant gave an account of the breeds in his country, the way they were used and any experimental or development work involving crossbreeding.

The discussion centred on the methods of exploitation of marginal land in order to accommodate the claims of livestock, forestry, recreation and protection of ecosystems and the need and methods of conserving local livestock breeds to fit into this multidisciplinary system. The recommendations called for more research, more surveys of livestock and land resources, more application of stratified crossbreeding schemes and more conservation of local breeds. A report will be published in English and French.

A

B

C

Postgraduate programmes in animal health and production offered by the James Cook University, Queensland, Australia

The programmes:

1. M.Sc. Course in Tropical Veterinary Science: 12 months duration, beginning February 1978. Major components: applied pathology, microbiology, parasitology, epidemiology and animal production with emphasis on tropical pasture agronomy, ruminant nutrition, reproductive physiology and animal breeding. Applicants must be graduates in veterinary science and should apply not later than 1 November 1977.

2. M.Sc. and Ph.D. Research Programmes: Research work in the general fields stated. Major projects in progress include aspects of the pathology of livestock, virology, immunology, helminthology, ruminant nutrition, reproductive physiology and animal breeding. Applicants, who must be graduates in veterinary science or related disciplines, can be considered for acceptance at any time.

3. Intensive course in tropical cattle production: 9 weeks duration, beginning March 1978; available to veterinary and agricultural graduates or diplomates. The programme includes field studies in the tropical environment in North Queensland where a range of different animal production and pasture utilization systems coexist.

Applicants should apply to the Registrar, James Cook University of North Queensland, Townsville, Queensland 4811, Australia, from whom further particulars can be obtained.

FAO/WHO meeting on African trypanosomiases

The WHO Expert Committee and FAO Expert Consultation on the African trypanosomiases met jointly from 8 to 12 December 1976 at FAO headquarters in Rome. The meeting was attended by 15 members of the two groups from 12 countries, six observers representing various research institutes and international organizations, and by 12 participants representing the secretariat of the meeting.

The meeting discussed recent progress regarding multiple aspects of human and animal trypanosomiases and then reviewed in detail aspects of African trypanosomiases under the following main headings: geographical distribution and incidence; study of parasites; epidemiology and epizootiology; diagnosis; pathology and immunopathology; problems regarding surveillance and investigations carried out in the field; chemotherapy and chemoprophylaxis; the campaign against tsetse flies and the programming and organization of this campaign, and training of personnel at all levels. The meeting also identified needs for future research within these areas and made recommendations on development of new techniques to improve the disease control campaign which is of considerable importance to most parts of the African continent. A detailed report of this important meeting will be published in English and French during 1977.

NEW BOOKS

research in maize feed; establishment of milk-processing plants; worldwide compendium of facts about livestock breeds; anabolic agents and public health

Maize feed for beef production

The maize crop as a basic feed for beef production, special issue, Vol. 1, No. 2, 3 October 1976 of *Animal Science and Technology*. Publication arranged by the Commission of the European Communities, Directorate General for Scientific and Technical Information and Information Management, European Centre, Krichberg, Luxemburg.

This special issue of the quarterly journal *Animal Science and Technology* contains the proceedings of an International Working Conference on current research and directions of future research on the maize crop as a basic feed for beef production. The Conference was held in Yugoslavia in June 1976 under the auspices of the Commission of the European Communities as part of the EEC programme of coordination of research on beef production. In addition to the nine EEC countries, Austria, Finland, Greece, Norway, Portugal, Spain, Sweden, Switzerland, Turkey and Yugoslavia participated in the research programme.

The work of the conference was organized in six sections: I. Survey of the use of maize for livestock feeding in each region; II. The effect of agronomic factors on the yield and composition of the maize crop, considered in relation to method of utilization; III. Efficiency of harvesting; IV. Nutritive value for beef cattle of diets based on the maize crop; V. Systems of production and efficiency of use of resources; VI. Requirements for future research. The forty technical papers presented under the six topics are reproduced together with a verbatim report of participants' contribution to the discussion.

This 500-page report provides a detailed survey of all aspects of the maize crop in western and southern European countries. The picture shows the remarkable expansion in production of maize, particularly in the southern part of continental Europe, which has been obtained largely through the development and use of high-yielding hybrids. This feature is well illustrated in the case of Italy, where in 1963, of the total area of 1 120 000 ha planted for maize grain, 40% were hybrid and 60% local varieties, with yields of 4.96 t/ha and 2.15 t/ha respectively. By 1975, on a reduced crop area of 896 000 ha, 88% were hybrid and 12% local varieties, with yields of 6.57 t/ha and 1.79 t/ha.

The report also brings out the greatly increased use of forage maize, mainly fed as silage, in beef production systems in all countries. Here the pattern is a progressive increase in the proportion of forage maize from south to north with grain production being negligible in Scandinavia, Britain and Ireland.

Although the participants in this conference were research workers their obvious close relations with commercial farming practice is notable. While the great contribution of research to production of hybrid strains, etc. is neatly shown, the equally important area of improving utilization and adapting beef production systems to the maize crop is given full coverage. The conclusions on the need for further research appear to be practically oriented to raise beef production efficiency in systems where maize is the major and most competitive feed. In the words of one of the participants, attention should be given to the "evaluation of maize feed by the animal because there is a big gap between the findings of economists and the needs of nutritionists and the demand of the animals."

This special issue provides a useful reference both on the maize crop in Europe and associated beef production together with current research programmes being pursued by countries in the region.

S.M.T.

Standardized pilot milk plants

H.S. HALL, Food and Agriculture Organization of the United Nations — Industry Cooperative Programme, Rome, 1976. 104 pages, 12 pages layouts, sections and plans, with a 22-page supplement containing Dairy Engineering Companies' Profiles issued by Industry Cooperative Programme (English, French and Spanish).

The publication is intended to provide a basis on which the processing of milk and milk products can be planned, at minimum cost, in a country or region where there is no established dairy industry. It is addressed to the governments or other agencies responsible for initiating such projects and to those who must implement the design, construction and operation of the milk plants which would be required.

The book deals with aspects of establishing a milk processing plant of a capacity of 25 000 litres per day, with equipment chosen in such a way that the daily throughput can vary between 50 and 150 percent of the nominal figure, without serious loss of operating efficiency.

The book is divided into five chapters in which the objectives of milk plant standardization, selection of processing divisions, building requirements, project planning and plant operation and layout are presented and discussed. These are illustrated with 36 figures and 16 photographs.

The book is likely to become a guideline for officials and professionals in developing countries who are responsible for establishing systems of milk marketing and particularly of liquid milk processing.

W.B.T.

Livestock breeds

Etnologia zootecnica, by T. BONADONNA. Unione Tipografico-Editrice Torinese, Turin, 1976. 788 pages. Price: It. lire 28 000. (in Italian)

In 1958 Professor Bonadonna published a mammoth work on cattle breeds which ran to over 1 000 pages. The cattle chapter of the present book appears to be a condensation and updating of the earlier book. It describes in alphabetical order 68 European cattle breeds of which 22 are Italian, 18 British and 13 French; 12 come from other western European countries and three must be considered international (Simmental, Brown Swiss and Friesian). There follow short sections on buffaloes, zebus, zeboids (taurindicus) and local and new breeds in Europe and elsewhere.

The pig chapter is arranged geographically. Short paragraphs describe the principal breeds (including new breeds) of Italy, Europe, North America, Latin America, and other regions.

Sheep breeds are classified as producers of fine-wool (Merino), meat, meat and wool, milk, and in each section the breeds are classified by country. There follow sections on Italian breeds (again classified by product), fur breeds (Karakul) and carpet wool breeds. Goats are grouped under European, Italian and other breeds.

Horses are classified as dolicomorphs (Arabians and thorough-breds), derivatives of these (including half-breds and ponies), brachimorphs (draught horses and Criollos) and mesomorphs (hunter, Hackneys, Friesians and Halflingers). Each section is subdivided geographically. There is also a short section on asses and mules. The last chapter describes bison, yaks, musk oxen, South American Camelidae and reindeer.

In compiling this monograph the author has clearly relied on his extensive travels throughout the world and on his previous publications. There is a bibliography of 66 pages of which seven are devoted to Bonadonna and his collaborators. There are 335 illustrations, most of which are photographs. These are not acknowledged, so presumably they were taken by the author himself.

It is unfortunate that the proofreading was not sufficient to remove all the errors in the spelling of foreign words, some of which indeed have been carried forward from the previous book. Nevertheless this is a remarkable compendium of facts from many countries and many languages.

I.L.M.

Anabolic agents in animal production FAO/WHO Symposium, March 1975

Edited by FRANK C. LU and JAN RENDEL. WHO, Geneva and FAO, Rome, 1976. George Thieme Publishers Stuttgart. 277 pages, numerous figures, tables and references. Price: DM 74.

Published as Supplementary Volume V to the series of Studies on Environmental Quality and Safety, this volume contains the lectures given at the FAO/WHO Symposium on the use of anabolic agents in animal production and its public health aspects. Among the topics discussed are the mode of action of anabolic agents in increasing protein production, animal responses to treatment with anabolic agents, the origin, absorption, metabolism, and disposition of endogenous and exogenous anabolic agents, and public health aspects arising from the use of anabolic agents in farm animals.

P.M.

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Recent FAO documents

The use of anabolic agents in animal production and its public health aspects. Report of the FAO/WHO Symposium held in Rome, 17-19 March 1975. 1975. MR/F9360. (Available in English, French and Spanish)

Summarizes the working papers presented at the sessions of the Symposium on protein accretion during growth and the mode of action on anabolic agents; animal responses to treatment with anabolic agents; the origin, absorption, metabolism and disposition of endogenous and exogenous anabolic agents, and public health aspects arising from the use of anabolic agents in farm animals. Includes a list of the working papers and a list of participants.

New feed resources. Report of the FAO Technical Consultation held in Rome, 22-24 November 1976. 1976. ISBN 92-5-100190-1. (In English. Available shortly in French and Spanish)

Reviews the discussions and recommendations of the Consultation relating to poor-quality roughages, agro-industrial by-products, by-products from the wood and cellulose industry, and recycling of animal and municipal wastes. Includes a list of the working papers and a list of participants.

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